$10

Digitized by the Internet Archive
in 2010

http://www.archive.org/details/dairycattlemilkp00eckl

DAIRY CATTLE AND MILK PRODUCTION

THE MACMILLAN COMPANY
NEW YORK · BOSTON · CHICAGO · DALLAS
ATLANTA · SAN FRANCISCO

MACMILLAN & CO., LIMITED
LONDON · BOMBAY · CALCUTTA
MELBOURNE

THE MACMILLAN COMPANY
OF CANADA, LIMITED
TORONTO

DAIRY CATTLE
AND
MILK PRODUCTION

PREPARED FOR THE USE OF
AGRICULTURAL COLLEGE STUDENTS
AND DAIRY FARMERS

BY

CLARENCE H. ECKLES, B.S.A., D.Sc.

Chief, Division of Dairy Husbandry, University of Minnesota
Formerly Professor of Dairy Husbandry, University of Missouri

REVISED EDITION

New York
THE MACMILLAN COMPANY
LONDON: MACMILLAN & CO., Ltd.
1929

All rights reserved

Copyright, 1911 and 1923
By THE MACMILLAN COMPANY.

Set up and electrotyped. Published 1911.
Revised edition, September, 1923. Reprinted June, 1924;
January, 1927; March, June, 1928; April, October, 1929.

PRINTED IN THE UNITED STATES OF AMERICA BY
THE BERWICK & SMITH CO.

PREFACE

Dairy Cattle and Milk Production, first published in 1911, has met with widespread favor from teachers of dairy husbandry and dairy farmers. During the twelve years that have passed since the first edition appeared, the available knowledge of dairy husbandry has been greatly broadened by scientific investigation, especially in the field of nutrition, physiology, and veterinary medicine. The new edition, retaining the plan of the old, has been completely rewritten and enlarged 244 pages by new topics and new chapters. Over 90 new illustrations are included.

The introductory chapter presents the economic reasons for the growth of the dairy industry and important facts of a historical nature. The arrangement of the material concerning the breeds, which met with general approval in the original edition, has been retained. The Brown Swiss and Guernsey breeds, in keeping with their increasing importance, are given separate chapters.

Special attention is given to the problem of breeding. A special chapter entitled Cattle Breeding deals with the fundamentals and points out the extent to which applications of Mendel's Law may be made. The practical application of breeding, which is the selection of the sire, receives especially detailed consideration.

The material on calf raising is expanded into two chapters with special attention to the problem of raising the calf when whole milk is sold. A chapter entitled Factors Influencing the Growth of Cattle is intended to present the scientific viewpoint as to growth. If found too difficult for vocational students, it may be omitted and attention given to the next chapter, which deals with the practical questions of raising the dairy heifers.

A new chapter of interest to breeders of pure-bred cattle deals with the business side of the pure-bred business.

The subject of feeding is covered by four chapters. As in the first edition, the subject is approached through feeding practice rather than through the presentation of a study of feeding standards. Two chapters deal with the practical questions of feeding practice, one with common feedstuffs, while feeding standards are considered in the fourth.

Milking and factors influencing the composition of milk receive the detailed treatment the importance of these subjects justifies. A new chapter is included on silos and silage.

It is the aim of the author to bring together in this book the essential information regarding the dairy cow in a compact and usable form. An immense amount of material exists on this subject. It is found in publications of experiment stations and scientific journals, in the agricultural press, and in the possession of practical herdsmen. The author has also drawn upon his own experience gained during a period of twenty-five years in charge of a dairy herd of from thirty to one hundred head of pure-bred animals, including the leading breeds. An attempt is made to assemble and present this information in a suitable form for the student of dairy husbandry. Emphasis is given especially to the principles he must understand and practice in order to be successful with dairy cattle. Although written primarily for the student of agriculture, it is hoped it will continue to be serviceable to the practical dairy cattlemen as well.

The author has been assisted in the present revision by his former student, Milton H. Fohrman, A.M., Dairy Husbandman, U. S. Department of Agriculture, who is responsible for the chapter on breeding and for liberal assistance with other portions of the material.

C. H. ECKLES

University of Minnesota
August, 1923

TABLE OF CONTENTS

CHAPTER PAGES

I. INTRODUCTION 1–18
  IMPORTANCE OF DAIRY FARMING 1–7
    History 1
    Number of Dairy Cows in the United States 5
    Milk as Food 6
  THE PLACE OF DAIRY FARMING IN A PERMANENT SYSTEM OF AGRICULTURE 7–18
    Dairying a Permanent Industry 7
    Relation of Dairying to the Fertility of the Soil . . 8
    The Cow as a Producer of Human Food 12
    The Cow as an Efficient User of Roughage 15
    Meat from Dairy Cattle 15
    Dairying a Safe Business 16
    The Labor Question 16

II. ORIGIN AND CLASSIFICATION OF DOMESTICATED CATTLE 19–27
    Origin of Cattle 19
    Origin of Breeds 22
    Value of Breeds 24
    Classification of Cattle 25

III. THE DAIRY TYPE 28–46
    General Considerations 28
    General Characteristics of the Dairy Type 28
    The Dairy Form 30
    Types of Cows 32
    Limitation of Selection by Type 33
    Development of the Barrel 34
    Circulation 36
    Milk Veins and Milk Wells 37
    The Udder 38
    Other Features 41
    Breed Type 42
    The Score Card 42

CHAPTER PAGES
IV. HOLSTEIN-FRIESIANS 47–63
Origin and Distribution in Europe 47
Conditions in Holland 48
Importations and Distribution in America 49
Size and Type 50
Breed Characteristics and Adaptations 53
Milk and Fat Production 56
Characteristics of Holstein Milk 57
Families 59
Advanced Registry 59
Summary of Advanced Registry Results 62

V. JERSEYS 64–77
Origin and Distribution in Europe 64
Conditions on the Isle of Jersey 64
Registration on the Island 65
Importations and Distribution in America 66
Size and Type 67
Influence of the Early English Breeders 68
Breed Characteristics and Adaptations 69
Dairy Characteristics 71
Advanced Registry 74
Prominent Jersey Families 76

VI. GUERNSEYS 78–86
Origin and Distribution in Europe 78
Conditions in Guernsey 79
Importations to America 81
Form and Characteristics 81
Dairy Characteristics 83
Guernsey Families 84
Advanced Registry Results 84

VII. AYRSHIRES 87–95
Origin and Distribution in Europe 87
Conditions in Ayrshire 88
Importation and Distribution in America 88
Breed Characteristics 89
Dairy Characteristics 93
Advanced Registration 94

CHAPTER PAGES
VIII. BROWN SWISS 96–103
Origin 96
Conditions in Switzerland 96
Importation and Distribution in America 98
Breed Characteristics 98
Dairy Characteristics 101
Advanced Registration 101

IX. MINOR BREEDS 104–109
Dutch-Belted 104–106
Importation and Distribution in America 104
Dairy Characteristics 105
Registration and Advanced Registry 106
French-Canadian 106
Kerry 107
Dexter 107
Devons 108

X. DUAL-PURPOSE CATTLE 110–126
General Discussion. 110–114
Definition of the Term 110
Adaptation of the Dual-Purpose Cow 111
The Shorthorn Breed 114–121
Origin and Development 114
Breed Characteristics 116
Dairy Characteristics 116
Shorthorns in England 119
Breed Organizations 119
Advanced Registration 120
Red Polls 121–126
Origin and Development 121
Importation and Distribution in America 123
Breed Characteristics 123
Beef and Milk Production 125
Advanced Registry 126

XI. GENERAL CONSIDERATION IN SELECTING A BREED 127–148
Choice of a Breed 127
Relative Efficiency of the Breeds 130

CHAPTER PAGES

XI. GENERAL CONSIDERATION IN SELECTING A BREED, Continued

Breed Characteristics in the Use of Roughage . . . 135
Community Breeding 137
Starting the Herd 142
Guarding against Disease 145

XII. THE SELECTION OF THE INDIVIDUAL COW 149–164

Necessity for Selection 149
Variation in Production by Individuals 150
Economy of High Production 153
Cause of Individual Variation 158
Reason for Economy of High Production 161

XIII. SELECTION OF THE INDIVIDUAL COW BY RECORDS OF PRODUCTION 165–182

Methods of Selection 165
Selection by Records 166
Overrating the Importance of Rich Milk 167
The Importance of the Milk Yield 169
Keeping Milk Records 170–178
Testing at Monthly Intervals 170
Keeping Daily Records 171
Method of Taking and Testing Samples 173
Calculating the Fat Yield 174
Form of Keeping Records 174
Adding Records 175
Form of Permanent Record 176
Cow Test Associations 178–182
Judging a Cow by her Two-Year-Old Record . . . 181

XIV. SELECTION, CARE, AND MANAGEMENT OF THE SIRE 183–210

General Importance of Selecting the Sire 183
Results from Using a Pure-Bred Bull 184
Importance of the Sire in the Pure-Bred Herd . . . 188
Differences in Transmission of Dairy Qualities by Different Bulls 189
Cause of Wide Variation in Prepotency of Bulls . . 193
How the Sire is Selected 194
The Proved Sire 200

CHAPTER PAGES
XIV. SELECTION, CARE, AND MANAGEMENT OF THE SIRE, Continued
Age as a Factor in Selecting a Bull 203
Relation of Dam's Age to Prepotency of Bull . . . 204
Feeding During the Growing Period 204
Age for Breeding 205
Ringing and Dehorning 206
Feeding the Mature Bull 207
Housing the Bull 207
Exercising the Bull 209
Proper Handling of the Bull 209

XV. CATTLE BREEDING 211–234
Methods of the Pioneer Breeders 211
Mendel's Law 213
Variation 216
Why Offspring of High Producing Cows are Often Mediocre 217
Effect of Environment 218
Law of Ancestral Heredity 218
Inheritance of Acquired Characters 219
Sex Determination 220
Relative Importance of Sire and Dam as a Source of Dairy Qualities 221
Prepotency 221
The Freemartin 222
The Pedigree 222
In-Breeding 223
Line-Breeding 226
Out-Crossing 227
Nicking 228
The Value of a Pedigree 228
Crossing Breeds 229
Value of Testing 231
Bull Associations 232
Why so Few Pure-Bred Bulls? 233
Summary 234

XVI. CALF RAISING 235–253
Economic Considerations 235
Importance in Maintaining the Herd 235

CHAPTER PAGES
XVI. CALF RAISING, Continued
Birth Weight of Calves 236
Raising Calves by Hand 238
Raising Calves on Skim Milk 238
Comparison of Whole Milk and Skim Milk for Calves 242
Taking a Calf from its Mother 243
Amount of Milk to Feed 244
Temperature of the Milk 245
Changing to Skim Milk 245
Supplements to Skim Milk 245
Hay and Pasture 247
Importance of Fresh Milk 248
The Creamery and the Skim Milk Calf 249
The Farm Separator and Calf Raising 250
Clean Pens a Necessity 250
Plenty of Water Needed 251
Mineral Matter for Calves 251
Fall or Spring Calves 251
Weaning 252
Feeding Schedule for Skim Milk Calves 252

XVII. CALF RAISING, Continued 254–281
MILK SUBSTITUTES. 254–267
Raising Calves without Milk 254
Milk Substitutes 254
Feeding Schedules for Calf Meals 256
Experimental Results 256
Raising Calves with the Minimum Amount of Milk 260
Powdered Skim Milk for Calf Feeding 265
Whey as a Feed for Calves 266
GRAINS AND ROUGHAGES. 267–268
Grain Mixtures for Calves 267
Roughages for Calves 268
CALF FEEDERS AND TIES. 268–270
Calf Feeders 268
Ties for Calves 269
VEAL PRODUCTION 270–275
Classification of Veal on the Market 273
Feeding for Veal 274

CHAPTER PAGES

XVII. CALF RAISING, Continued

DISEASES OF CALVES 275–281
- Scours from Indigestion 276
- Bloody Scours 277
- White Scours 277
- Calf Pneumonia 279
- Arthritis 280
- Navel Ills 280
- Ringworm 280
- Lice 281

XVIII. FACTORS INFLUENCING GROWTH AND DEVELOPMENT OF HEIFERS 282–319
- Nature of Growth 282
- Two Factors Concerned in Growth 282
- Limits of Growth 283
- Measuring Growth 283
- Normal Growth 284
- Internal Cause of Growth 287
- Influence of Size of Calf at Birth on Growth 288
- Breed as a Factor in Growth 289
- Heat, Light, and Ventilation 290
- Influence of Gestation upon Growth 290
- Effect of Lactation upon Growth 292
- Effect of Nutrition upon Growth 295
- Influence of Age at First Calving 304
- Combined Effect of Lactation and Nutrition . . . 304
- Recovery from Retarded Growth 306
- Cause of Milk Secretion 310
- Relation of Size of Cow to Total Milk Production and Economy of Production 312
- Influence of Ration During the Growing Period on Dairy Qualities and Type 313
- Influence of Age at First Calving on Dairy Qualities and Type 316
- Factors Influencing the Age of Sexual Maturity . . 318
- Influence of the Ration on Breeding Qualities . . . 318

CHAPTER PAGES
XIX. RAISING THE DAIRY HEIFER 320–337
Use of Normal Growth Figures 320
Feed and Care of the Heifer after Weaning 321
Alfalfa Alone and with Grain Supplement 323
Use of Silage in Winter Rations for Heifers 325
Alfalfa Hay and Silage for Growing Heifers 326
Practical Winter Rations for Dairy Heifers 327
Various Concentrates for Supplementing Silage . . 329
Quantities to Feed at Various Ages 330
Relation of Winter Ration to Summer Gains . . . 332
The Breed Factor 332
Age at Which to Breed 334
Care of the Heifer before Calving 334
Barns for Young Stock 336

XX. PURE-BRED HERDS—THE BUSINESS SIDE OF THE PURE-BRED BUSINESS 338–358
What is a Pure-Bred. 338
Registration 338
Advanced Registration and Official Testing 339
Objections to Short-Time Tests 342
Number of Pure-Bred Cattle 345
Pure-Breds vs. Grades 346
Possibilities of a Pure-Bred Herd 347
Reputation an Asset 348
Breeders' Business Code 349
Advertising the Herd 350
Acquiring a Knowledge of Pedigrees 351
Naming Pure-Bred Cattle 352
Suggestions to Breeders 353
Selling by Mail 355
The Public Sale 357

XXI. CARE AND MANAGEMENT 359–377
Importance of Proper Management 359
Regularity and Gentleness in Handling 359
Exercise and Grooming 360
The Period of Gestation 361
Fall vs. Spring Calving 361
Dehorning 363

CHAPTER PAGES
XXI. CARE AND MANAGEMENT, Continued
Training the Horns 365
Marking Cattle 365
Sheltering Cows 368
Persistency in Production 370
The Fly Annoyance 370
Decline in Milk Production in Summer 373
Supplementing the Pasture 375
The Summer Silo 376
Length of Time a Cow is Profitable 376

XXII. CARE AND MANAGEMENT, Continued 378–392
Giving the Cow a Rest 378
Drying off the Cow 379
Management of the Dry Cow 380
Rations of the Dry Cow 382
Milking Before Calving 382
Care of the Cow at Calving 383
Retention of the Afterbirth 384
Care of the Cow after Calving 385
Guarding against Milk Fever 386
Care of Newborn Calf 386
Developing Long Milking Period 387
Water for Cows 388
Watering Cows in the Barn 390
Warming Water for Cows 390
Salt Requirements 391

XXIII. MILKING FACTORS INFLUENCING THE QUANTITY AND QUALITY OF MILK 393–428
MILKING. 393–402
Milking the Heifer 393
Methods of Milking 393
Milking More than Twice Daily 395
Hard Milking Cows 397
Use of the Milking Tube 397
Sterilizing Instruments 398
Cows with Leaking Teats 398
Bloody Milk 398
Chapped Teats 398

CHAPTER PAGES

XXIII. MILKING FACTORS INFLUENCING THE QUANTITY AND QUALITY OF MILK, Continued

Warts on the Teats 399
Kicking Cows 399
Self-Sucking Cows 399
The Milking Machine 399
FACTORS INFLUENCING QUALITY AND QUANTITY OF MILK. 402–427
Breed 402
Size within the Breed 403
Intervals between Milkings 403
Variations from Day to Day 404
Bitter, Rancid or Stale Milk 405
Seasonal Variation 406
Stage of Lactation and Milk Yield 408
Stage of Lactation and Fat Percentage 410
Effect of Gestation 413
Feed in Relation to Yield and Richness 415
First and Last Milk Drawn 416
Condition of Flesh at Calving 417
Influence of Œstrum 418
Influence of Drugs 419
Relation between Daily and Yearly Production . . 419
Milk Production, Advanced Registry Conditions Compared to Ordinary 421
Influence of Age upon Richness of Milk 425

XXIV. COMMON AILMENTS OF CATTLE 428–450
Instruments and Medicine Needed 428
Drenching a Cow 429
Tuberculosis 429
Abortion 435
Udder Troubles 440
Milk Fever 443
Lice 446
Pink Eye 447
Foot Rot 447
Bloat 448
Impaction 449
Actinomycosis (Lumpy Jaw) 449
Cowpox 449

CHAPTER PAGES
XXV. FEEDING FOR MILK PRODUCTION 451–468
Turning Cows on Pasture in the Spring 452
Grain Feeding on Pasture 453
When to Feed Grain 454
Providing for Periods of Short Pasture 455
The Relative Economy of Silage Crops for Summer Feeding 456
Disadvantage of Silage 457
The Summer Silo 458
Feeding Soiling Crops 458
Maintaining Summer Conditions throughout the Year 459
Amount to Feed 459
Avoiding Overfeeding 462
Relation of Live Weight to Proper Feeding 463
Feeding as Individuals 464
Amount of Grain and Roughage to Feed 465
Rules for Practical Feeding 466
Succulent Feed 466
The Protein Supply 467
Feeds Classified according to Protein and Total Digestible Nutrients 467

XXVI. FEEDING FOR MILK PRODUCTION, Continued 469–481
Palatability 469
Variety 469
Proportion of Nutrients from Roughage 471
Lightness of Ration 472
Home Grown Rations 473
Mineral Matter in the Ration 475
Preparation of Feeds 478

XXVII. FEEDING FOR MILK PRODUCTION, Continued 482–495
FEEDING PRACTICE. 482–490
Cause of Milk Secretion 482
Feeding after Freshening 482
How Much to Feed 483
Order of Feeding 484
Limits of Grain Feeding 485
Grain Feeding in Irrigated Alfalfa Districts 489

CHAPTER PAGES
XXVII. FEEDING FOR MILK PRODUCTION, Continued
Feed and Care of Cow on Official Test 490–495
Fitting for Test 490
Short Time Tests 493
Long Time Tests 494
Grain Mixtures for Official Test Feeding 494

XXVIII. CHARACTERISTICS OF COMMON FEEDS . . . 496–508
Fodder 496
Straw 497
Oat, Wheat, Rye, Barley.
Hay 497
Timothy, Alfalfa, Clover, Soy-bean, Cow-pea.
Silage 498
Corn, Kaffir, Sorghum, Pea and Oat, Legume, Sunflower.
Roots 499
Tubers, Mangels, Rutabagas, Sugar Beets, Potatoes, Pumpkins.
Concentrates 500
Corn, Bran, Middlings, Oats, Barley, Rye.
By-Products 502
Cottonseed Meal, Cold Pressed Cottonseed Cake, Linseed Meal, Gluten Meal, Gluten Feed, Brewers' Grains, Distillers Grains, Dried Beet Pulp.
Molasses and Mixed Feeds 505
Buying Feed by Analysis 507
Alfalfa-Molasses Feeds 507
Stock Feeds 508

XXIX. THE FEEDING STANDARD AND THE CALCULATION OF RATIONS 509–520
The Requirements of an Animal 509
Composition of Feeds 509
Digestibility 510
The Feeding Standard 511
Calculating a Ration 513
Deficiencies of a Ration Shown by the Feeding Standard 514
Value of Feeding Standards 516
Determining the Cost of Nutrients 518
The Balanced Ration 519

CHAPTER PAGES
XXX. THE SILO AND SILAGE 521–531
History 521
Advantages of the Silo 521
Losses in the Silo 522
Fermentations in Silage 523
Construction of the Silo. 524–526
Size of Silo to Build 524
Essentials of Silo Construction 525
The Wooden Stave Silo 525
The Concrete Silo 525
The Tile Silo 526
The Pit Silo 526
Other Types of Construction 526
Crops for the Silo 526
Proper Stage of Maturity for Corn 528
Sunflowers 529
Other Crops for the Silo 529
Filling the Silo 529
Spoiling of Silage 530
Capacity of Silos 531

XXXI. THE SOILING SYSTEM AND SOILING CROPS 532–538
General Advantages of Soiling 532
Objections to the Soiling System 535
Crops for Soiling 536

XXXII. STABLES FOR COWS 539–559
Better Barns Mean Cheaper Production 539
Types of Barns 540
Location of the Barn 544
Lighting 544
Floor Construction 545
Wall Construction 548
Arrangement of Cattle in Barn 549
Gutters 552
Mangers 552
Ties and Stanchions 553
Box Stalls 554
Water Supply and Drainage 555
Ventilation 556
Planning to Save Labor 559

CHAPTER PAGES
XXXIII. HANDLING MANURE—MATERIAL FOR BEDDING 560–568
  Composition of Manure 560
  Value of Manure as Measured by Crops 561
  Amount of Fertility Returned 561
  Losses in Manure 562
  Preservation of Manure 563
  Handling of Manure 564
  The Litter Carrier 566
  Bedding 566
  Materials for Bedding 568

APPENDIX A

Digestible Nutrients in Feeds 569
Mineral Elements in Common Feeds 572
Number of Dairy Cattle by Breeds and States 573
Gestation Table 574
Estimated Weight of Settled Silage 575

APPENDIX B

Score Cards for the Ayrshire Breed 576
Score Cards for the Brown Swiss Breed 579
Score Cards for Guernsey Cattle 580
Score Cards for the Holstein Breed 582
Score Cards for the Jersey Breed 584

DAIRY CATTLE AND MILK PRODUCTION

DAIRY CATTLE AND MILK PRODUCTION

CHAPTER I

INTRODUCTION

Importance of Dairy Farming

Milk, with its products, serves as one of the most important sources of food for all civilized nations. The more highly developed and prosperous the people, the greater the amount of milk and dairy products they consume.

Martiny[1] points out that the native races of Africa, America, and Australia, which have never developed beyond the stage of barbarism, do not use milk as a food. The primitive races of Europe and Western Asia made use of milk, as their descendants have done, and to this fact, according to Martiny, is due in no small degree the great intellectual development of Europe and America.

McCollum in presenting the results of his investigations in human nutrition, which have changed the viewpoint of the entire civilized world on the subject, remarked: "The keeping of dairy animals was the greatest factor in the history of the development of man from a state of barbarism."

A large part of the best agricultural lands of the world are utilized for the keeping of dairy cattle. It is a well-known fact that the most prosperous nations, as well as the best developed physically and mentally, are those in which the dairy cow is the foundation of agriculture.

History. As far back as history records, man has been in possession of cattle and has made use of milk and of products made from milk. In the oldest parts of the Bible, references are made to milk, butter, and cheese.[1] The people of Greece, 1000 to 450 B.C., used butter and cheese; and one of their writers described the composition of milk. The people of Rome, 750 B.C. to 475 A.D., used dairy products, and cheese became an important article of commerce. From Rome a knowledge of the use of milk and its products spread over Europe. By 800 A.D. the use of cheese was common in what is now Germany. The Normans, who were powerful at this period, also used cheese as a common article of food.

---

[1] Martiny, Benno, Kirne and Girbe.

During the Dark Ages the art of cheese-making was best known and developed in the monasteries. The monks for several centuries were the leaders in carrying on the business and in teaching it to others. By the year 1000 cheese had become an important article of trade in the cities of Europe, and by the fifteenth century some important cheese markets were in existence in Switzerland which were conducted very much as they are at present. One Swiss cheese introduced by the monks has been made in the same region and under much the same conditions since about the tenth century.

Holland and Switzerland were the two early centers of development of the dairy industry in Europe, and they have retained this position to a large extent up to the present time. The English apparently learned the use of milk—especially in the form of butter and cheese—from the Romans.

We are indebted to Europe for our breeds of dairy cattle, for most of our knowledge of dairying, and for our practices in regard to using milk and our methods of manufacturing products from it. Although the first cattle were brought to America by Columbus on his second voyage, the development of dairying in the United States was slow for more than a hundred years after the first settlement. The early settlers in practically all cases brought animals with them from their native homes. These were mixed indiscriminately, and from these sources are descended the cattle known as "natives," which, until the widespread introduction of improved blood in recent years, included a large proportion of the cattle of America.

---

[1] *Genesis* 18:8; *Judges* 5:25; *Psalms* 55:21.

For about two hundred years after the first settlements were made, practically no improved blood, in the present meaning of that term, was introduced from Europe or was available here. Beginning about 1820, importations were made, from time to time, of an individual or a small group of animals representing the various improved breeds since then well established in America. It was not until nearly fifty years afterward that herd books were established for the registration of pure-bred animals of the present dairy breeds.

In the colonial days in America the cow was seldom expected to produce milk in winter time. She calved in the spring, milked fairly well on grass, dried up in the fall, and sometimes died of starvation during the winter. Children's health suffered for lack of milk. Utensils and methods were crude and the products inferior.

These conditions changed slowly up to 1850. Since that date more progress has been made in the dairy industry than had been made from the dawn of history up to that time. The great landmarks in the development of the dairy industry in America since 1850 may be enumerated as follows:

Shipping milk. The first milk train was run in 1850. At this time the milk supply of the cities either came from cows kept within the city, or was hauled from short distances.

The factory system. The introduction of the factory system of dairy manufacture has had widespread influence upon the entire industry. The first cheese factory was established by Williams in Oneida County, New York, in 1851; the first creamery by Stewart in Iowa, in 1871.

Condensed milk. Condensed milk was invented by Gail Borden, an American, in 1856. In 1920, 5.3 per cent of the milk production in the United States (the product of one and a third million cows) was used for this product.

Dairy organizations. In 1850 there were no dairy organizations. The Dairy Breed Associations were established between 1860 and 1880 and the state dairy associations mainly between 1875 and 1895. The first cow test association in America was organized in 1905. The movement for coöperative manufacture and marketing of dairy products began between 1890 and 1900.

The centrifugal separator. The centrifugal separator was invented about 1877. The power size was put into use in 1879, and hand machines were introduced about 1890. The separator has revolutionized the dairy industry.

The Babcock test was invented in 1890. Today cream and milk worth more than a billion dollars annually are sold according to this test.

Cold storage. Artificial refrigeration, introduced about 1880, has had a far-reaching effect upon markets and prices by tending to stabilize prices and supply.

Relation of bacteriology to dairy products. As a result of discoveries in the field of bacteriology the close relation between bacteriological action and the quality of the manufactured dairy products is now recognized, also the importance of safeguarding dairy products designed for human food.

Educational agencies have been established which include the organization of dairy instruction in agricultural colleges, in schools, and in extension activities.

Milk in relation to human nutrition. Beginning about 1910, investigations in nutrition have shown the true importance of milk in the diet.

Improvement in cattle. Between 1860 and 1880 the foundation stock was imported from which most of our present dairy stock are descended. An average production of 225 pounds of butter per year for a herd was held as unusual in 1860. At present an average of 400 pounds for a herd would attract far less attention.

Number of Dairy Cows. Table 1 shows that the ratio between the human population and the number of cows in the United States has remained essentially the same since 1850. This does not indicate that the consumption of milk per capita has remained constant. It has in fact increased considerably in recent years; but at the same time the average milk production per cow has also increased, making it possible to supply an increased demand with a somewhat smaller number of cows per thousand of people. Because meat is an expensive food the tendency is to use less of it and more of dairy products. This practice will undoubtedly continue in the future. In time, cheese will be consumed in larger quantities and will take the place of meat to a greater extent, as has long been the case in Europe.

TABLE 1. POPULATION AND NUMBER OF DAIRY COWS ON FARMS AND RANGES IN UNITED STATES EXCLUSIVE OF OUTLYING POSSESSIONS

YEAR	POPULATION	NUMBER OF DAIRY COWS	NUMBER OF PERSONS PER COW
1850	23,191,876	6,385,094	3.6
1860	31,443,321	8,585,735	3.7
1870	38,558,371	8,935,332	4.3
1880	50,155,783	12,443,120	4.0
1890	62,947,714	16,511,950	3.8
1900	75,994,575	17,135,633	4.4
1910	91,972,266	20,625,432	4.5
1920	105,710,620	23,724,148	4.0

Table 2 shows the total number of cattle and the classification of dairy cattle as enumerated by the census of 1920.

TABLE 2. CATTLE ON FARMS (1920)

Total cattle	66,652,559
Beef cattle, total	35,288,100
Dairy cattle, total	31,364,459
Calves under one year	6,867,991
Heifers 1 year old and under 2	4,048,851
Cows 2 years old and over	19,675,297
Bulls 1 year old and over	772,320

The difference between the figures given for dairy cows in this table and the figures in Table 1 results from the change in age classification. The figure given in Table 1 is estimated by the Census Bureau for comparison. The total value of dairy products in 1909 was, in round numbers, 596 million dollars; in 1919 it reached a total of one and a half billion—an increase in value of 148 per cent in ten years. The increase in amount at the same time was 18 per cent.

Milk as Food. From the earliest historical times, all civilized nations have used milk and its products as food. It has long been observed that mankind seems to have a natural craving for milk, which is especially noticeable when completely deprived of milk and dairy products for several months. Its importance as a food for infants is also generally recognized. However, the full explanation of the important relations of milk to the diet has been forthcoming only within the past decade.

Previous to the investigations of McCollum, Hart, Mendel, Osborn, and others, milk was valued as food from the same standpoint as other food products—that is, as a source of bodily energy and of protein. On this basis milk makes a very favorable showing. Now, however, as a result of the investigations referred to, it is recognized that the question of a proper diet is far more than one of supplying a sufficient amount of energy and of protein, and the proteins must not only be ample in amount but of suitable quality. Proteins from grains and vegetables are somewhat lacking in quality and their deficiencies are best made up by the use of some animal protein. Of all proteins the protein of milk is the best adapted for making up what is lacking in a ration largely composed of cereals. This is true for animals as well as for man—as is illustrated by the remarkable results of adding skim milk to a grain ration received by pigs or fowls.

The second remarkable discovery that greatly emphasizes the value of milk as food was that of the vitamines. These substances, of which four have been discovered so far, are necessary for the growth of the young and for the well-being of mature humans and animals. They are produced by plants, from which source man and animals must get them directly or indirectly. All four vitamines are found in milk. The only other single source of all four is green leaves. It is not practical for man to arrange his diet to supply the necessary vitamines from green plants, and he has come to depend largely upon milk and dairy products for these indispensable substances.

A third great advance that has been made in the knowledge of nutrition concerns the mineral requirements. It has long been known that certain minerals are necessary for both man and animals. Only in recent years, however, has the extent to which man and domestic animals suffer from a deficiency of certain minerals been recognized. Lime is the substance most often lacking, although phosphorus—and at times iodine—are also consumed in too limited quantities. Milk is an especially good source of lime.

McCollum says, "Milk is the great factor of safety in making good the deficiencies of the grains which form, and must continue to form, the principal source of energy in our diet. Without the continued use of milk, not only for feeding of our children but in liberal amounts in cookery, we cannot as a nation maintain the position as a world power to which we have arisen."

THE PLACE OF DAIRY FARMING IN A PERMANENT SYSTEM OF AGRICULTURE

Dairying a Permanent Industry. A study of agricultural development in the past removes any question as to the permanent character of dairy farming. The history of agriculture in all civilized nations shows that grain-growing is usually the first type of farming developed. The next stage in the history of agriculture is a decline in the fertility of the soil and in grain production—the result of continued cropping. This results in greater attention to livestock of all kinds. As a rule, the first cattle industry of any magnitude is that of beef raising, which is followed by a gradual change to dairy production, combined with more or less general farming. When this stage is reached, the fertility of the soil is retained or improved; and a permanent form of agriculture is reached. The dairy districts of Europe have gone through these stages; they were at one time chiefly grain-producing regions, and later engaged in beef production.

A considerable portion of the United States has already passed through these successive stages. With other portions the changes are still in progress. As examples of states where these stages of development are reasonably complete, the following might be mentioned: New York, Pennsylvania, Ohio, Wisconsin, and Michigan. The history of agriculture shows that dairying is a permanent type of agriculture; and in later paragraphs the reasons are described.

The experience of mankind for thousands of years has shown the absolute need of milk in the diet. One of the best known authorities on human nutrition said, "Without milk the white race cannot survive." Furthermore, the reasons why milk is an absolute necessity in the human diet is now understood and, as a result, the consumption of dairy products in the future is certain to increase. It is also shown that the cow returns more human food from a given amount of feed than any other domestic animal.

The most practicable means of keeping up the fertility of the soil is the use of farm manure, made possible by the keeping of a liberal number of livestock. These facts furnish a firm foundation for the faith of the dairy farmer in the permanent character of his industry. Man has used dairy products as far back as history records and recent investigations have made clear the extent to which the human family has become dependent upon the cow.

Relation of Dairying to the Fertility of the Soil. It is conceded that the conservation of the fertility of the soil is the greatest problem of agriculture. The fact is well established that it is possible to maintain the fertility of the soil where grain crops are sold from the farm. Even granting it is possible, however, it is certain that it is seldom done. So far, in our history, grain-selling has meant selling fertility that has been stored up in the past ages; and it has been followed by impoverished soils and unprofitable agriculture. On the other hand, we find farms in almost every locality—and even entire countries can be pointed out—where the fertility of the soil has been vastly increased by livestock farming. The most marked examples of this are connected with dairy farming, and the fundamental reason is shown by Table 3.

Of the ten or eleven chemical elements apparently necessary for plant growth, only three are liable to be lacking in sufficient quantities in the soil. These are nitrogen, phosphorus—measured as phosphoric acid—and potassium—measured as potash. The fertilizing value of barnyard manure depends upon the amount of ingredients contained. Commercial fertilizers used in enormous quantities in the older agricultural sections of the eastern and southern states supply one or more of these three elements in a form suitable for the use of plants. These commercial fertilizers have a well established market value which depends upon their content of these three elements.

Farm crops also have a value as fertilizers, based as in the case of commercial fertilizers, upon their content of nitrogen, potash, and phosphoric acid. From the market price of commercial fertilizers may be calculated the market value of a pound of each of the three important elements mentioned. By applying to the composition of crops the figures thus obtained it is possible to calculate the cost of replacing the elements of fertility contained in 1,000 pounds of these crops by purchasing commercial fertilizer at market prices. The normal prices for nitrogen seems to be about 20 cents a pound; for potash and phosphoric acid 5 cents a pound.

TABLE 3. FERTILIZING CONSTITUENTS AND VALUE AS FERTILIZER IN 1000 POUNDS OF MATERIAL

	LBS. NITROGEN	LBS. PHOSPHORIC ACID	LBS. POTASH	VALUE PER TON AS FERTILIZER
Corn Fodder	17.6	5.4	8.9	$8.47
Timothy Hay	12.6	5.3	9.0	5.50
Red Clover Hay	20.7	3.8	22.0	10.86
Alfalfa Hay	21.9	5.1	16.8	10.95
Wheat Straw	5.9	1.2	5.1	3.00
Corn	18.2	7.0	4.0	8.38
Oats	20.6	8.2	6.2	9.68
Wheat	23.6	7.9	5.0	9.33
Wheat Bran	26.7	28.9	16.1	15.28
Linseed Meal	57.8	18.3	13.9	26.20
Cottonseed Meal	66.4	26.8	17.9	31.03
Milk	5.3	1.9	1.8	2.49
Cheese	45.2			18.08
Butter	1.6			.64

A study of this table makes plain the cause of the difficulty experienced in maintaining the fertility of the farm when the selling of grain crops is followed for a term of years. Each bushel of wheat takes from the farm fertility that would cost 27 cents if replaced in the form of commercial fertilizers. A bushel of corn removes fertility worth, on the market, 23 cents. A ton of alfalfa hay sent to market carries with it fertility worth $10.95 on the market. At times the farm prices for roughages is little more than the actual fertilizing value would be if purchased in the form of commercial fertilizer. It should be stated, however, that with alfalfa, clover, and other legumes, the nitrogen comes largely from the air and the soil of the farm is not depleted of nitrogen by selling these hays. On the contrary, due to the accumulation of nitrogen in the roots, this important element is increased in the soil when these crops are grown even if they are sold from the farm.

Dairy products, however, take but little from the farm in proportion to their selling value. Milk carries from the farm about 13 cents worth of fertility in each 100 pounds and taxes the fertility of the farm far greater than does the sale of any other dairy product. Even then, at $2 a hundred for each dollar's worth of fertility sold in milk an income of $12.60 is received, while with corn at 75 cents a bushel each dollar's worth of fertility brings only $2.65 when sold. The sale of butter or cream takes from the farm so little of value as a fertilizer that it is hardly worth considering. Since butter fat contains only carbon, hydrogen, and oxygen, it has no value as a fertilizer. The only element of fertility in butter is the small amount of nitrogen contained in the curd, amounting in value to only 64 cents per ton, while the market value of this amount of butter at 35 cents per pound is $700.

A dairy cow weighing 1,000 pounds voids about 12 tons of solid and liquid manure in a year—worth, in round number, $28.00 at the market price of the three elements of fertility contained. Under proper conditions from 70 to 80 per cent of the manure voided by farm animals may be saved and returned to the soil.

The Ohio Experiment Station[1] obtained an actual value of $4.69 per ton for manure when applied at the rate of 8 tons to the acre in a five-year rotation. The average of all their extensive investigations showed an average value of $2.97 measured in increased crops grown.

The Purdue Experiment Station[2] reports crop increases worth from $2 to $8 with an average of $5 for each ton of manure applied, the variation depending upon the fertility of the soil and the rate of application.

But this does not tell all the story. The dairy farmer usually is a purchaser rather than a seller of grain, and by this means adds constantly to the fertility of his farm. The purchase of

[1] Bulletin 246 (1912). [2] Bulletin 222 (1918).

concentrated feed rich in protein, as will be seen from the table, adds a large amount of fertility to the farm. Furthermore, the keeping of dairy cattle usually means that a large proportion of the land is kept in grass, consequently making it possible to prevent washing of the soil, which is responsible for the rapid deterioration of many farms.

It is a well-known fact that the yield of grain per acre of the agricultural lands of Denmark, Germany, and parts of England where dairy farming has been followed for a period of years has materially increased during the past fifty years.

The Cow as a Cheap Producer of Human Food. Henry and Morrison say[1], "As land, labor, and feed increase in price the dairy cow will more and more displace the strictly meat-producing animals, for she produces human food with far greater economy than does the steer, sheep, or pig."

TABLE 4. PROPORTION OF FOOD EATEN BY VARIOUS CLASSES OF LIVESTOCK THAT IS RETURNED FOR HUMAN USE

	PER CENT OF PROTEIN RETURNED		PER CENT OF ENERGY RETURNED		
	Of Total Food	Of Digestible Protein	Of Total Food	Of Digestible Protein	Of Production Value of Food
Cow . . .		41.0			48.9
Cow . . .		31.4			40.6
Dairy Herds.	14.7	22.9	10.00	15.1	33.8
Steer . . .		8.9			17.0
Steer . . .	6.4	11.8	4.7	6.9	14.8
Hen . . .	16.1	20.9	7.1	8.3	14.1
Poultry flock	14.5	18.6	6.4	7.5	12.6
Hog . . .	10.2	13.2	15.1	17.5	29.9

The data in Table 4 show that the cow produced more human food from a given quantity of feed than was produced from any other farm animal. As producers of protein, hens are the nearest competitors of dairy cows, while as producers of energy the pig ranks second. However, both the hen and the hog require more concentrated food in proportion to the roughage than the cow, and in this way, except as consumers of waste products, they are hardly as efficient as the figures in the table indicate.

---

[1] *Feeds and Feeding*, 17th edition, page 338.

Figures given in Table 5 have been compiled from data taken by the author to show the comparative production of food constituents by the dairy cow and by a high class beef-steer. The comparison is made of the milk produced by a Holstein cow in one year with the composition of the carcass of a fat steer weighing 1,250 pounds.

TABLE 5. COMPARISON OF FOOD CONSTITUENTS PRODUCED BY A COW AND A STEER

	COW, 18,405 LBS. MILK	STEER, WT. 1,250 LBS.
Protein	552	172
Fat	618	333
Sugar	920	
Ash	128	43
Total	2218	548

The total dry matter in the milk was 2,218 pounds, all of which is both edible and digestible. The steer, with a live weight of 1,250 pounds, contained 56 per cent of water in the carcass, leaving a total of 548 pounds of dry matter. In this dry matter of the steer is included hair and hide, bones and tendons, organs of digestion and respiration; in fact, the entire animal, a considerable portion of which is not edible. The analysis of the steer's carcass was made from samples taken after grinding together one half of the complete carcass.

The cow produced proteids sufficient for more than three steers; nearly enough fat for two; enough ash to build the skeleton for three; and, in addition, 920 pounds of milk sugar, worth as much per pound for food as ordinary sugar. In the comparison in Table 5 the cow was far above the ordinary, and for this reason the following additional data given by the author are to show the amount of human food produced in a year by cows of ordinary productive ability.

Table 6. Milk and Milk Constituents Produced in a Year by Ordinary Cows

	Average of Three Jerseys, Lbs.	Average of Two Ayrshires, Lbs.	Average of Two Holsteins, Lbs.
Milk	7,110	6,329	8,750
Protein	293	204	272
Fat	403	233	282
Sugar	312	311	406
Ash	53	39	59
Total Solids	1,061	787	1,019

Table 6 shows that these ordinary cows all produced more protein in a year than was contained in the carcass of a 1,250-pound steer. Three of them also produced more fat. The solids of all except two contained more ash than was found in the carcass of the steer. In addition, each cow produced from 290 to 437 pounds of sugar. The seven cows, representing three breeds, in one year averaged 970 pounds of total solids each, or nearly as much as was contained in the carcass of two steers.

A comparison of the feed consumed by the steer and the cows would be still more striking, since the steer required nearly two years of liberal feeding to build his carcass, and during the fattening period the ration was mostly grain. The product from the cows was made in less than one year, and largely from roughage. On the other hand, the dairy cow had to be fed two years before she came into milk, although when once mature she is productive for at least five or six years. It is also recognized that the labor requirements in caring for the cow are much more than for the steer.

The Cow as an Efficient User of Roughage. The special value of the cow as a domestic animal arises from her ability to consume and digest large quantities of roughage and to convert it into milk and meat suitable for the digestion of man.

The hog is a wonderful producer of meat, exceeding all other animals in regard to the amount of flesh produced from a given amount of feed, but the hog can use only limited amounts of roughage.

The sheep can utilize coarse feeds to advantage, but other factors prevent the keeping of a sufficient number of them to use the immense quantities of roughage available.

The production of large amounts of roughage is necessary, and it is unavoidable in connection with the growing of crops; and the cow and the steer must be relied upon almost entirely to convert this into a form suitable for human food. A considerable portion of the land in most agricultural sections is suitable only for pasturing on account of its being too wet or too dry, too hilly, or too rocky. Such regions naturally develop a livestock industry. On farms growing crops freely it is necessary to practice rotation of crops, resulting in quantities of hay and silage being available that can only be used by livestock of some kind, but best of all by cattle.

Meat from Dairy Cows. Although cattle of the dairy breeds are kept primarily for milking purposes, they furnish nearly one half of the beef supply of the United States; and in addition they are the source of nearly all the veal that goes to market, amounting to more than nine million head annually.

As population becomes more dense and the value of animal feeds higher, a still larger proportion of the meat supply will come from dairy animals. This condition has long existed in Europe, where beef is primarily a by-product of dairying; and there is evidence that the same factors are at work in America which will in time cause the beef produced from beef breeds to become too expensive for general use.

From 1910 to 1920 the number of dairy cows in the United States increased 15 per cent, while the increase in those classed as beef animals was only 5 per cent. Between 1900 and 1910 the numbers of beef animals actually decreased, while the dairy herds were materially expanded. The fundamental reason for this is the greater efficiency of the dairy cow as a producer of human food, as shown earlier in this chapter.

Dairying a Safe Business. One of the advantages of dairy farming which appeals to the farmer—especially a farmer with limited capital—is the quickness and the certainty of the returns. The dairy cow gives an immediate return and her product is always marketable. There is little of the element of speculation in this line of farming. The returns, while not large at any one time, are steady throughout the year and may be depended upon. The market price of dairy products varies on the whole less than almost any other class of farm products.

As a result of these conditions the development and expansion of dairy farming, particularly in the Mississippi Valley states, has in the past developed with the greatest rapidity during periods of financial depression in agriculture. The general farmer at such times finds it desirable to produce sufficient dairy products to meet his current expenses at least.

The Labor Question. The problem of securing sufficient and satisfactory labor is generally considered the greatest difficulty encountered in conducting a dairy farm. This difficulty arises from the necessity of treating the cow carefully at all times, and especially from the fact the work becomes somewhat monotonous because of having to be done regularly every day. Although the labor problem is a serious one, it is no worse than that experienced in almost any other branch of farming; and, in fact, under proper conditions it may be less serious.

Dairy farming does require the constant attention of the owner or employees; but there are advantages as well as disadvantages to this situation. A bricklayer working one half the year will seldom accumulate much property; neither will the farmer whose productive labor is confined to a few months out of the year, as is the case when a single crop is grown for market. In the long run, the farmer, as well as the mechanic, who works throughout the year will prosper the most. Dairying gives the farmer an opportunity to use his time regularly throughout the year. Members of his family also find work adapted to their age and strength.

The grain farmer crowds his work into a few months and requires a large amount of help for a few days or weeks only; and he finds this help almost impossible to secure, since he has no work to offer for the remainder of the year. He has little reason to complain if an abundance of extra labor is not at hand for the short period he is willing to utilize it. Labor on the dairy farm is distributed throughout the year, and arrangements may be made accordingly.

Regulating labor conditions. The objections raised by hired help to labor on the dairy farm are the long hours, the steady, regular work, and to some extent, the nature of the work itself —or rather to the conditions under which it is done. To reduce the labor problem to the minimum, first of all the hours must be made as reasonable as in other types of farming in the same community. Arrangements should be made so that the milkers are through with their work as early as men doing field work. Some provision must also be made for regular time off by each laborer in turn. If the owner is doing his own work he should realize that he should follow the same practice himself and take some time away from his work, otherwise in time he will come to dread the monotony of it.

The objections sometimes made to the nature of the work come almost entirely from the conditions under which the work is done, and that may be largely removed. If the cows are milked in a clean, well-lighted, comfortable stable at reasonable hours, and modern methods of handling the manure and feed by overhead carriers are installed, the objections to the work will largely disappear. In most localities a man with a family, if provided with a comfortable house, may be employed by the year with the best satisfaction to both the laborer and his employer.

CHAPTER II

ORIGIN AND CLASSIFICATION OF DOMESTICATED CATTLE

Origin of Cattle. There are no cattle native to America. All those found in North and South America are descended from animals brought from Europe. The domesticated cattle of Europe are descended from wild forms that originally lived in Europe and Asia. Where and by whom cattle were first domesticated is unknown, as it took place in prehistoric times. Within recent years considerable light has been thrown on the subject by extensive investigations regarding the early types of cattle and their relationship to the domesticated breeds of the present.

The chief sources of knowledge regarding the original types and the place of origin are bones—largely skulls—found, usually, on the sites of dwelling places of prehistoric races. These remains from different sources are carefully compared with each other and with corresponding specimens from various breeds and types of modern cattle and their near relatives from all parts of the world. The ruins of dwellings used by the Lake Dwellers in Switzerland has yielded an unusually large amount of valuable material of this kind. Ancient historical records and works of art which depict cattle have also been most carefully examined by those studying this problem. The literature on the subject is large, but the material gathered, while extensive, is so fragmentary that even those who have given the subject the most thorough study do not agree on more than the general details.

It has been established that cattle existed in Europe at least before the final retreat of the glaciers. According to Tyler[1], the domestication of cattle probably took place near the beginning of the New Stone Age, which he estimates to be 6000 B.C.

---

[1] *The New Stone Age in Europe* (1921).

Although there is a wide divergence of opinion concerning the origin of domesticated cattle, most investigators of the subject agree that the cattle of Europe are descended from two original types or species. One is called the *Bos longifrons* by some authors, while other authors use the term *Bos sondaicus*. The second type is known as the *Bos primigenius*.

Among the recent students of the subject is Keller[1]. This author believes that cattle were domesticated long before the records of history began—while the ancestors of the present Europeans still dwelt in Asia. About 6000 B.C. the ancestors of the Lake Dwellers of Switzerland are believed to have migrated from Asia, taking with them their domesticated cattle. Numerous remains of this race are found in the oldest ruins of the Lake Dwellers in Switzerland. The animal, which was of the *sondaicus* type, is believed to have been the first of domesticated cattle and to have been related by origin to the Banting or native wild ox of Asia, still found in small numbers on certain islands of the East Indies.

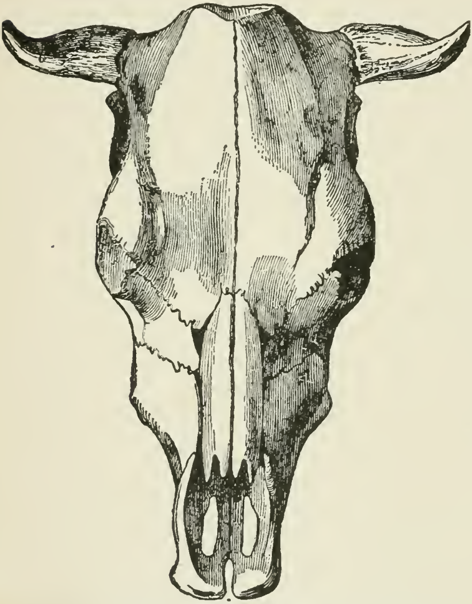


Fig. 1.—Skull of *Bos longifrons* (*Bos sondaicus* Keller). Note the broad head and short horns. This type is well represented by the Jersey breed.

These cattle were brought into Europe during the great migrations that took place and were spread over the greater part of that continent. At that time these cattle were small in size, and short-bodied, and had small horns. From this type Keller believes that most of our breeds in use today are descended, including the Brown Swiss, Jersey, Guernsey, and all the breeds of England except the Longhorn and Scotch Highland. However, part of the English breeds—the Shorthorn and Ayrshire in particular—while having this type as a foundation, were probably mixed in the early days of their breeds with the blood of the *Bos primigenius* type, through cross-breeding with Holland cattle.

---

[1] *Naturegeschichte der Haustiere.*

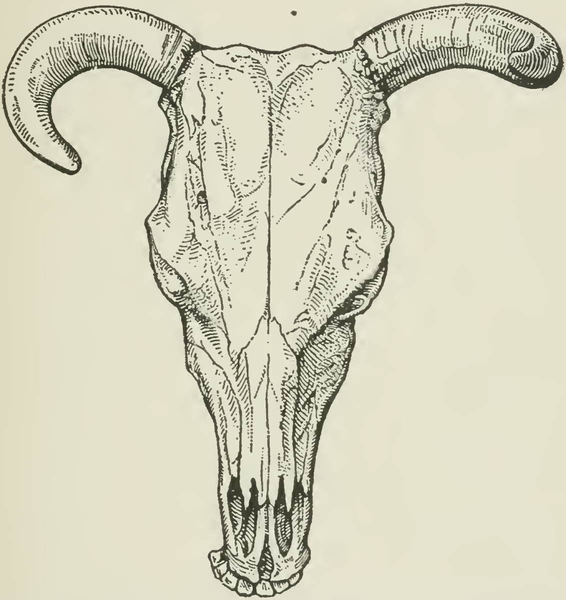


Fig. 2. Skull of *Bos primigenius*. Note the long narrow head. The Holstein is a good representative of this type

The *Bos primigenius*, known as the Urus in the time of Cæsar, was an immense, powerful animal, standing six to seven feet high at the withers[1]. The horns were long and slender, curving forward near the middle and ending with the points slightly upwards. Historical records show that this form existed in a wild state in Europe until the twelfth or thirteenth, and possibly the fourteenth, century. This animal was apparently domesticated in Europe within historic times. From it are descended the cattle of Holland and other parts of North Europe; the large, long-horned cattle of Hungary and adjacent regions; and the Longhorns and Scotch Highland breeds in England.

The most fundamental difference between the two original forms of cattle was the shape of the skull, and this difference is still evident in modern breeds. The *Bos primigenius* was characterized by a long, narrow head. This type of skull is well illustrated by the modern Holstein, whose long narrow head is taken to indicate descent from the original long, narrow form. The remains of the *Bos longifrons*, or the *sondaicus* type, show a broad short head, which characteristic is best illustrated by the short broad head of the typical Jersey, and which is found somewhat less marked in the Brown Swiss.

Origin of Breeds. The number of breeds and sub-breeds of cattle is surprisingly great. On the continent of Europe alone between forty and fifty distinct breeds are described by German and French writers. Great Britain is the home of eleven breeds, which have been imported to the United States, and in addition to this as many more minor breeds are described by English writers as of local importance.

With few exceptions these numerous breeds have been long established and historical records are not available to indicate their origin. One exceedingly important factor was the ancestry of the breed as between the two forms of wild cattle from which our present domesticated forms are descended. This difference in origin is presumably the greatest factor in causing the wide differences between the Holstein and the Jersey breeds—these two representing better than other common breeds the two lines of descent from the original wild forms.

---

[1] Morse, E. W., *The Ancestry of Domesticated Cattle.* Twenty-seventh annual report, Bureau of Animal Industry, U. S. Dept. Agr. (1910), pp. 181–239.

Another factor in the formation of breeds was the conquest of one country by another, as the result of which a new mixture generally resulted from the cattle introduced by the invaders. In the early historical times whole peoples migrated at times for long distances, taking their cattle with them. For example, the Simmenthaler breed in Switzerland reveals the same characteristics of skull as found among the original cattle of Sweden, from which localities the Burgundians are supposed to have migrated about 400 A.D.

Next to these two factors already mentioned come conditions of environment, such as climate, food, and topography of the country. In early times, with no organized means of transportation, little exchange of animals took place from one locality to another except as in the cases mentioned, when a whole people migrated or conquerors brought in a new type of animal. In these times there was little if any attempt at improvement. The effects of natural conditions were allowed to work out almost undisturbed by the selection of man. Breeds formed by such means may be called natural breeds.

Up to about 1770 these natural conditions and the introduction of new types by the means of conquest and migration, as previously noted, were the chief factors in the development of distinct breeds. Beginning about 1770, a great interest was aroused in England in the improvement of the quality of cattle and other domestic animals of Great Britain. This exceedingly important movement seems to have started largely as the result of the work of Robert Bakewell[1]. This pioneer in the art of breeding began active operations about 1760 and continued until his death in 1795. The activities of the Collings Brothers in improving the Shorthorn breed, beginning about 1780, rank next to those of Bakewell in calling public attention to the possibilities of livestock improvement. The remarkable movement initiated by these two men for the improvement of domestic animals spread over Great Britain and influenced the entire civilized world as well; the beginning of modern improved breeds is to be traced back to it.

---

[1] *Journal, Royal Society of England*, Vol. LV, pp. 1–31 (1894).

The methods developed and emphasized by these pioneer breeders are essentially the same as those followed today; careful selection of breeding animals, liberal feeding, and general good management. Bakewell was the first to understand and practice in-breeding and line-breeding as a means of fixing desirable characteristics. A certain amount of crossing was also done in the early history of some breeds—with the Ayrshire and the Shorthorn, for example.

At the present time the efforts of cattle breeders are directed toward further improvements in the breeds already in existence and not towards the establishment of new breeds. The reason for this is the realization that breeds are now in existence that are adapted to practically any conditions under which cattle may be profitably kept. Furthermore, to develop a new breed with as well-established characteristics as those already in use would require more than the lifetime of a man, and would not be financially remunerative.

Value of Breeds. The breed is only one of many factors to be considered in carrying on profitable milk production. In some cases the value of the breed is overestimated, but more often the reverse is true. Our present dairy breeds represent the efforts toward improvement in certain definite lines made by several generations of breeders. It would be folly for a man to attempt to start at the beginning to build up for himself what has taken a century or more for others to build. By making use of animals of a highly developed breed, adapted to the purpose for which they are to be used, he is taking advantage of all the work that has been done and starting at the highest point of advancement reached by other breeders.

On the Market. Cows of a distinct dairy breed usually—and rightly—sell for more than the same number of cows of mixed or unimproved breeding, even if the latter are known to be equally good as dairy cows. The cows of a distinct dairy breed are worth more to the buyer, because he can reasonably expect these animals to show the typical character of the breed to which they belong in production of milk, in disposition, and in other breed characters. Further, he can reasonably expect that these cows, when mated with a male of the same line of breeding, will produce offspring which will have the same typical breed characters. A cow of mixed breeding, even if a good dairy cow, or an unusually good milker in a breed where milking qualities are not generally found, cannot be counted upon to reproduce herself in her offspring. It is a well-known fact in animal breeding that the longer a certain character has existed in a breed, the more certain it is to be transmitted.

Pure breeds have been bred generation after generation with certain objects in view, and in the course of time these characters become fixed as breed characters, and are transmitted. It is easy to understand why the chances are good for getting a good dairy cow if the ancestors are the Holstein—known to have been bred about 2,000 years in one locality and noted for hundreds of years as great dairy animals—or if the parents are Jerseys, bred for 500 years, or longer, along one line.

Classification of Cattle. Various classifications of cattle have been made, some based upon geographical distribution, as lowland and mountain cattle, and others upon their anatomy, especially the shape of the skull. Today American writers arrange them according to the economic value as beef breeds, dairy breeds, and dual-purpose cattle.

No system of classification has yet been devised that can be applied in more than a general way to the individuals that make up the great mass of cattle. If we undertake to arrange them by breeds, we find, in addition to the numerous pure breeds, animals with all possible mixtures of the blood of two or more breeds, or with more or less improved blood mixed with the scrub, or unimproved. If we should attempt to arrange them according to the purpose for which they are adapted or kept, we would have a constant gradation from the extreme beef to the extreme dairy development.

It is difficult even to arrange a suitable classification of the pure breeds, since the animals may vary greatly within a breed on account of environment and treatment. The following descriptive terms are in common use:

Scrub. A scrub is an animal of mixed or unknown breeding, without the type or markings of any recognized breed. Other terms used with practically the same meaning are native, mongrel, or unimproved, as well as other names of a local character, such as "piney woods." These terms generally indicate that the animal does not carry more than at least a small amount of the blood of any of the improved breeds. Typical scrubs are not numerous except in those sections where very little attention is given to cattle raising. The term "scrub" is often applied also to inferior animals of any breeding.

Cross-bred is a term used to indicate that the animal is the offspring of parents of distinct breeds, either high grades or pure bred.

Grade. This term is generally used with a certain breed name, as Grade Jersey or Grade Shorthorn. This means that the animal in question has one-half or, usually, more of the blood of the breed mentioned. When the proportion of the pure blood is large, the animal is called a "high grade." The proportion of the blood predominating may be so great that for all practical purposes the animal is the same as a pure bred; but it cannot be called a pure bred, no matter how many crosses have been made, and such animals cannot be registered in the various Herd Books.

Pure bred. The term "thoroughbred" is often improperly used for the proper term, "pure bred." The term thoroughbred is properly applied only to the well-known English breed of horses. Pure-bred cattle, as understood in America, are those whose ancestors came from the native home of the breed in question and conformed to the requirements of this breed here. This blood must be kept pure and unmixed, and records must be available showing the descent from these ancestors. The records of descent of these animals are kept in a systematic manner by associations formed for the purpose by those interested.

The breeds of cattle common in America are usually classified as dairy, dual-purpose, and beef.

Dairy Breeds	Dual-Purpose	Beef Breeds
Holstein	Shorthorn	Shorthorn
Ayrshire	Red Polls	Hereford
Jersey	Polled Durham	Aberdeen Angus
Guernsey	Devon	Galloway
Dutch-Belted		
Brown Swiss		

In addition to the above, small numbers of French-Canadian, Kerry, and polled Jersey cattle, all to be classed as dairy breeds, are found in certain localities of America.

CHAPTER III

THE DAIRY TYPE

THERE is but one entirely satisfactory way to select cows for dairy purposes, and that is by records of production of each individual, as determined by the use of scales and the Babcock test. Official testing of pure breds and cow-test association work have made commendable progress during the past decade; but there are still vast numbers of cows used for dairy purposes on which no tests for milk and butter fat production have ever been made. In determining the value of such animals for dairy purposes the estimate must be based upon conformation, or the degree to which the animal approaches what is known as the dairy form or type. The excessive development of the function of milk production through generations of selection and breeding in that direction has brought about certain characteristics in the conformation of the animal that may be taken into account in judging of the development of these functions.

The breeders of Jersey Island in 1834 formulated the first scale of points for dairy cattle. At the present time the breeders' associations have prepared for each breed a carefully drawn scale of points that are of assistance in acquiring a skill in the selection of cows by conformation. A scale of points undertakes to describe the conformation of the animal that, in the judgment of the author, denotes the highest development of the characteristics sought. The comparative importance of the parts described is represented by points that total 100 for the perfect animal. The lack, up to the present time, of a real scientific basis for preparing a scale of points makes them unsatisfactory in many ways, but of great general value, especially to the beginner.

The General Characteristics of the Dairy Type. "Type," in this connection, refers to the conformation of the animals which indicates or suggests the purpose it serves. A person familiar with cattle in general, but not with highly developed dairy cattle, looking for the first time upon a high-class dairy cow in full flow of milk would have his attention especially directed to three points as follows:

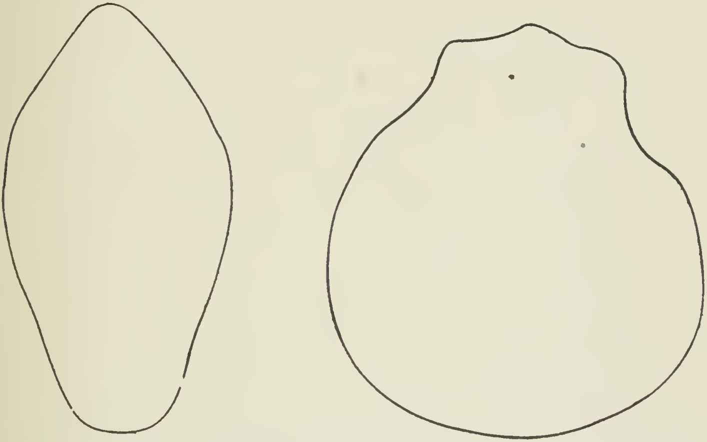


Fig. 3. Cross-sections of a high-class dairy cow at the heart girth and the paunch

1. The extreme angular form, carrying no surplus flesh, but showing evidence of liberal feeding by a vigorous physical condition.

2. The extraordinary development of the udder and milk veins.

3. The marked development of the barrel in proportion to the size of the animal.

These three points should be kept in mind as describing the special characteristics of the dairy animal in comparison with those bred for beef, or with inferior dairy animals. Sometimes the error is made of attributing this lack of flesh, so characteristic of a good dairy cow, to insufficient feeding. The dairy cow does not, however, have the same appearance as an animal not of the dairy type that is in thin flesh on account of insufficient feed. A high-class dairy cow never carries much flesh when in full flow of milk. The stimulation to produce milk is so strong that all the feed she can consume and digest above that needed for maintenance is utilized in producing milk. Such an animal, although thin in flesh, has an alert, vigorous appearance, her hair is soft and healthy, her skin pliable and loose, her eyes are bright, her paunch is full, and a general appearance of thrift and contentment is noticeable. An animal thin in flesh on account of insufficient food has a stupid appearance and shows a lack of vigor, while the rough, long hair stands on end. The paunch may be large or not, depending on the bulkiness of the feed consumed by the animal.

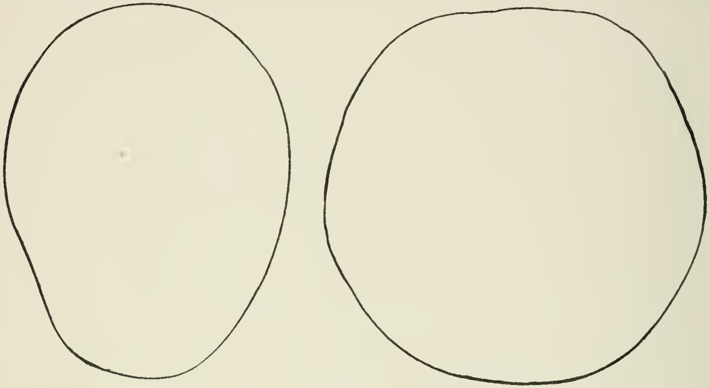


Fig. 4. Cross-sections of a high-class fat steer at the heart girth and the paunch. Contrast the smooth round withers and loins of the steer with the angularity of the cow in these parts.

The Dairy Form. The modern high-producing dairy cow is a result of selective breeding. This means that her ancestors have proved their productive ability and that they approach the breeder's ideal of good dairy form. Their function has been to produce large quantities of milk, and observant breeders have found that this function demands that the animal be so formed that she has the bodily equipment to carry on the work of milk secretion. Breeders have found that certain characteristics of form are always associated with high productive ability, and they consider these features in selecting their breeding stock. First among them is the general shape of the animal. The body of the dairy cow should be angular or wedge shaped, as viewed from the front, the side, or top of withers. The point of one wedge is at the withers with its base resting on the hip points. The base of another wedge would be on the floor of the chest with its point at the withers. The body should be deeper from the hip points to the bottom of the udder than it is at the fore quarters. The bases of these wedges are evidences of capacity, as they indicate width at the hips, width of the chest, and depth of body. Angularity and sharp wedges are the signs of dairy temperament. So characteristic is this angular appearance of the dairy cow that an animal that does not show this form when in full flow of milk should not be selected.

It should be understood that it is natural for a cow to fatten considerably toward the end of her milking period and when dry. This surplus fat is taken mostly from the body during the first three or four weeks after calving. It is impossible to fatten a high-class dairy cow with any ration during the best part of her milking period, or even to keep the fat that is on her body at calving time from being removed during the first few weeks she is in milk.

The cow that shows these characteristics to a marked degree is said to have a good dairy temperament. This means she is endowed by nature with a strong stimulation to produce milk, and uses practically all the nutrients she can digest for milk production. This accounts for the spare form and absence of any surplus fat, even when the animal evidently has abundant food. As a result of the above, a high-class producing cow when in milk is usually thin and sharp over the withers, her backbone stands out strong and prominent, and her hips and pelvic region stand out almost free from flesh.

When the cow is dry, or nearly so, she should carry more flesh than when in full flow of milk, and she should not be criticised on this account. The breed type should be taken into account as well, and the mistake avoided of judging all by the same arbitrary standard.

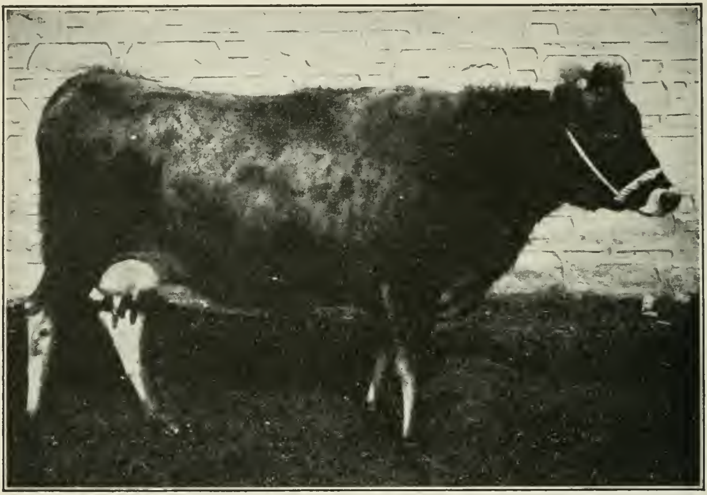


Fig. 5. A pure-bred Jersey cow. She is a vigorous healthy animal, but lacking in dairy conformation and milk producing ability. Average record for four years, 2,501 lbs. milk, 122 lbs. fat.

Types of Cows. Fig. 5 is a good illustration of a cow lacking in dairy temperament, although she is a pure-bred animal of one of the leading dairy breeds. This animal has a capacious barrel, and a splendid digestion, an unusually large heart girth, and a soft, pliable skin. She lacks the stimulation necessary to use her food for producing milk. This is shown by her thick withers, thick covering of flesh over the back, and general smooth, beefy appearance. Fig. 6 illustrates the other extreme. This cow has so strongly developed the tendency to produce milk that she uses the greater part of all the food she can eat and digest for this purpose and carries no surplus flesh. Her withers are thin and sharp, and her back and pelvic region angular and bony, although she receives a liberal ration.

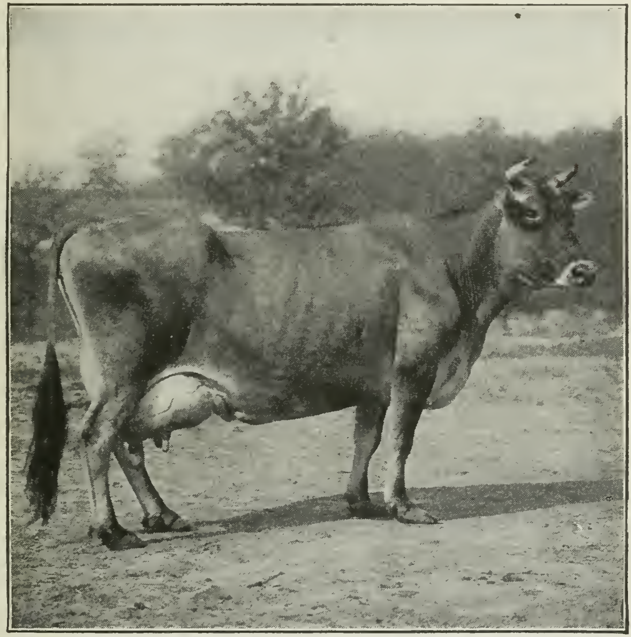


FIG. 6. A pure-bred Jersey cow. A winner in the St. Louis World's Fair test. Her outstanding ability as a milk producer is in keeping with her excellent dairy conformation. Note the contrast with Fig. 5.

A cow should be expected to carry somewhat more than her normal flesh for a short time after calving, but this beefy appearance should disappear within a month or less.

Limitation of Selection by Type. The selection of dairy cows by type, as indicated, is often uncertain. Still, the practical breeder or dairyman must select most of his animals in this way. The limitations should be understood. Any one familiar with dairy type will seldom fail to choose between a high-class animal and an inferior one—as, for example, between the cow shown in Fig. 5 and that in Fig. 6. Usually it is easy to choose between a cow producing 350 pounds of butter fat in a year and one producing 150 pounds. However, as between the good and the extraordinary cow, type gives little upon which to base selection.

The author has yet to see a cow of extraordinary dairy quality that does not conform to the descriptions given in the following pages. While in some cases these cows would fail to score high on account of not conforming to the score card in some respects; for example, on account of a weak fore udder or a sloping rump, they showed the important characteristics described later in every case. On the other hand some cows exhibit all the characteristics of high producers in regard to type, but fail in not having sufficient stimulation to produce large quantities of milk. To judge a dairy cow with any accuracy, she must be in milk, and preferably near the best stage of her milking period. A dry cow offers in most cases very little upon which to base judgment. A dairy cow thin in flesh from underfeeding is also in a condition that makes it almost impossible to form any estimate of her value.

Development of the Barrel. The dairy cow that is a heavy producer must have large organs of digestion in order to utilize the enormous quantities of feed necessary to produce large quantities of milk. This results in the development of a large barrel, as that part of the animal's body between the fore and rear legs is called. A high-producing cow has widesprung ribs far apart, and a deep abdomen, giving great capacity for the digestive tract and other vital organs. An animal lacking in this barrel capacity cannot use sufficient feed to be a large producer. The age of the animal has some influence on the size and depth of the abdomen. The depth of the barrel increases some with the age of the cow. The feeding of a ration consisting mostly of bulky feeds, as hay and silage, also tends to

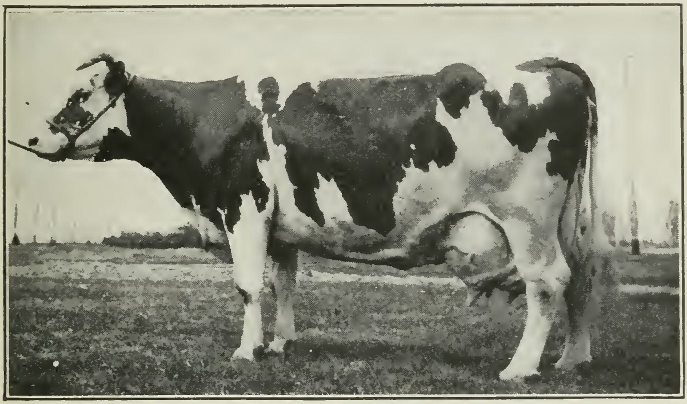


FIG. 7. Holstein cow, Spring Brook Bess Burke. She has a splendid development of the barrel and udder. Her best official record is 25,227 lbs. milk, 875 lbs. fat.

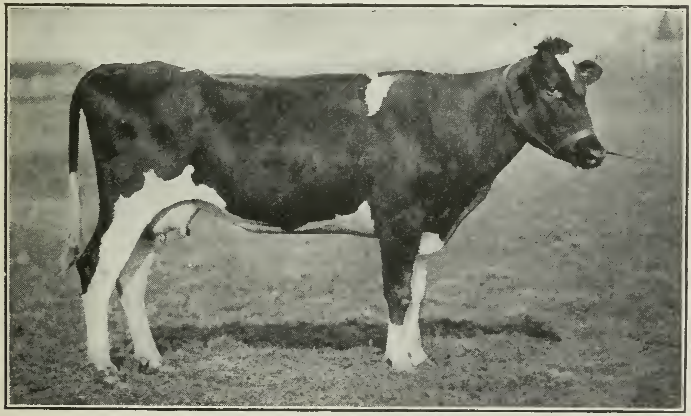


FIG. 8. A pure-bred Holstein cow. An extreme example of a lack of capacity in the barrel. A cow of this type should be avoided

give the appearance of greater barrel capacity from the greater contents of the digestive tract. In considering the barrel development of a cow, the depth as viewed from the side should be observed, then the width as viewed from behind. Some animals show a great depth, but on account of being narrow have no more real capacity than another animal with less depth, but greater width.

Fig. 7 is an illustration of a Holstein cow of great capacity. She shows an exceptionally good development of the barrel. Fig. 8 is a Holstein equally as well bred as the former, but on the other extreme in dairy capacity. She shows an unusually small development of the barrel, in keeping with her inferior dairy qualities.

Circulation. After the food is digested and absorbed into the circulation it must be carried to other organs of the body and undergo many changes before it is secreted in the form of milk. A strong, active circulation is of great importance, since without it the whole organism lacks tone. The circulatory system includes the heart, lungs, arteries, and veins. A large heart girth is usually assumed to indicate a large capacity of the heart and lungs. There is, however, some question as to the relation between the size of the body at the point called the heart girth and the size of the vital organs, but there are few exceptions to the rule that cows of great milk-producing capacity, especially those that continue to produce for a series of years, have more than an average development in this respect. A soft, pliable skin is also an indication of a good circulation. When the animal has good "handling qualities," it means the small blood vessels below the skin are active and that the animal is in good health. A clear, bright eye is also an index of a good circulation. When the cow is sick, or is by nature dull and sluggish, circulation is poor and the skin feels dry and hard, with rough upstanding hair, and her eyes lack luster.

The Milk Veins and Milk Wells. The most important point to be observed regarding the circulation is the development of the milk veins. The blood, after supplying the udder with material for milk secretion, starts back towards the heart through the milk veins. One of these opens on either side near the front line of the udder attachment to the body, and passes forward just beneath the skin. These veins crook back and forth more or less, in some cases divide into two or more

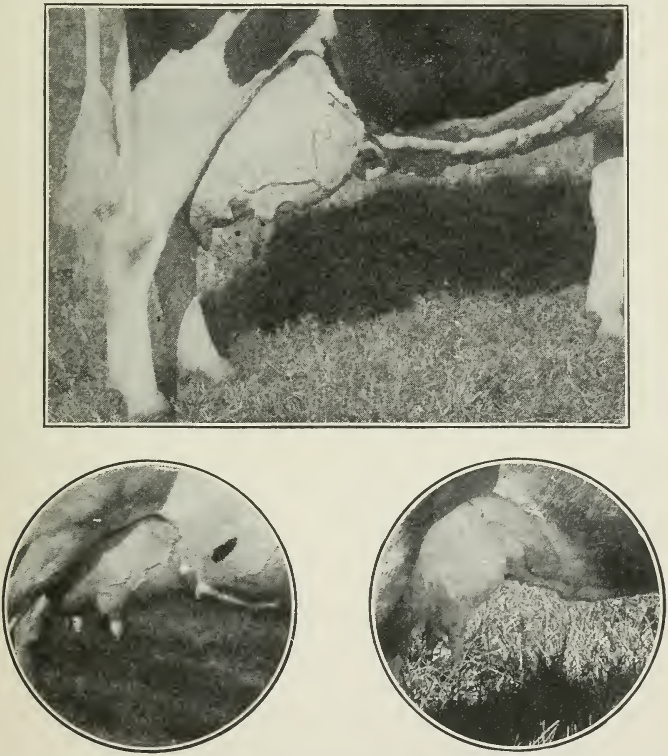
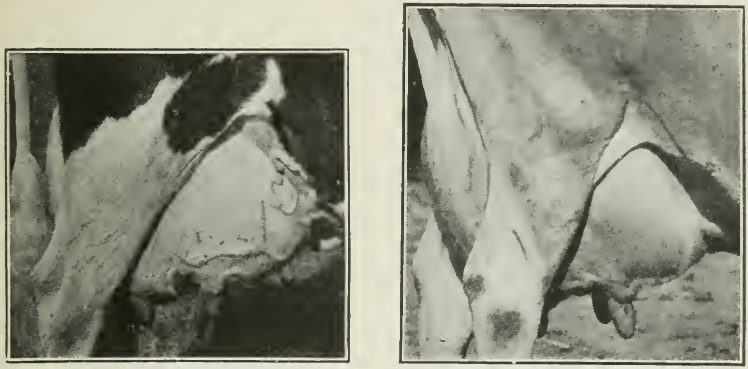


Fig. 9. Well-developed milk veins. The size of the milk veins leading forward from the udder is an important indication of the milk-producing ability of a cow.

branches, and finally pass upwards through one or more openings in the wall of the abdomen into the body cavity. The portion of the veins from the udder to the opening through which it passes into the abdomen is called the milk vein. The opening in the abdomen through which the vein passes is popularly known as the milk well. Fig. 9 shows exceptionally good development in this respect. The milk vein is one of the most reliable indications of dairy capacity, since a large production of milk calls for a large quantity of blood to pass through the udder, and a large milk vein denotes such a circulation. The size of the milk vein is influenced to a great extent by the age of the cow. In a young animal the vein is smaller and more elastic than in the aged cow. When a cow is producing the maximum amount of milk, the veins are larger than is the case when the same animal is dry. The milk wells, on the other hand, remain practically a constant size after the cow is once mature. In judging a dry cow, or one far advanced in the period of lactation, the size of the milk well is of greater importance than the size of the milk veins.

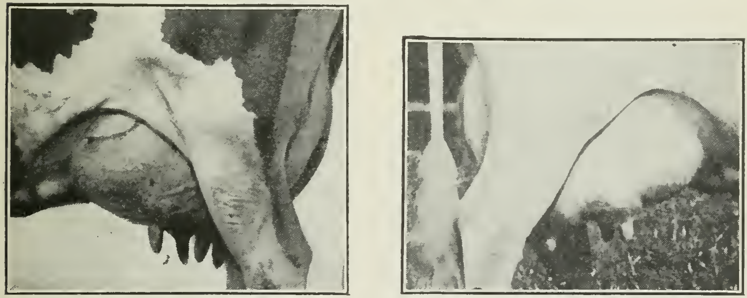
The Udder. The development of the udder is of the greatest importance in selecting the cow, especially in regard to its size and shape. In the manufacture of milk, the food of the cow is first digested, then absorbed into the blood, which passes by circulation to the udder. The udder consists of two large glands which are more or less distinctly divided to correspond with each of the four teats. The duct of each teat enters a small cavity called the milk cistern. The main body of the udder is made up of glandular or secretory tissue, connective and fatty tissue. Since this gland is responsible for the secreting of milk from the blood, its size and development are the most important of all as indicating the dairy qualities of the cow.

It is not the size of the udder alone that is important, but the number of active secreting cells. An udder gland filled with inert cells and fatty tissue is not effective. This is illustrated by the meaty udder in Fig. 11. This is a large, well-formed udder, but the cow is a very moderate milker. Her udder is nearly as large after milking as before. The best type of udder has a long attachment to the body, both in front and behind. A good circulation of blood and healthy tissue is indicated by the soft, pliable skin and prominent veins. Before milking, the udder is naturally considerably ex-



Holstein. 22,593 lbs. milk, 709 lbs. fat

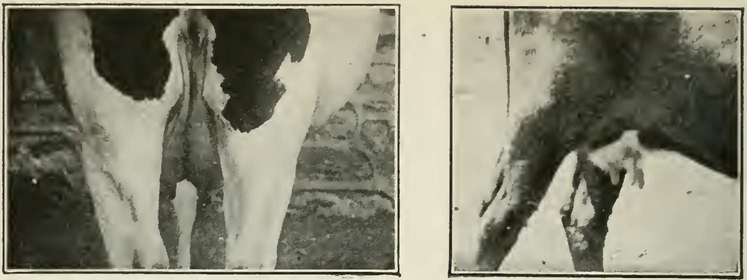
Jersey, Sophia 19th, of Hood Farm. 17,557 lbs. milk, 999 lbs. fat



Guernsey, Countess Prue. 18,626 lbs. milk, 1,103 lbs. fat

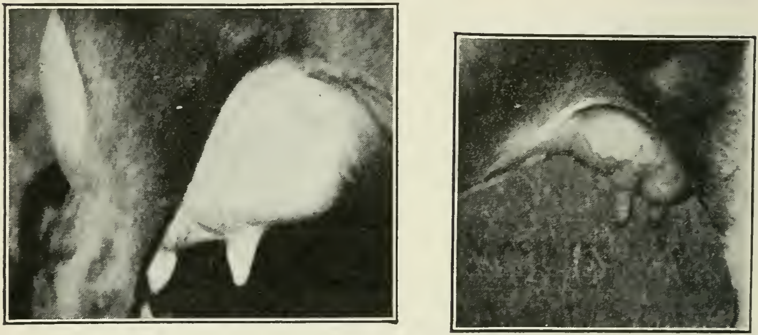
Ayrshire, Lily of Willowmoor. 22,596 lbs. milk, 956 lbs. fat

Fig. 10. Well-developed udders. Cows that rank high in milk production always have large udders and usually well-developed ones



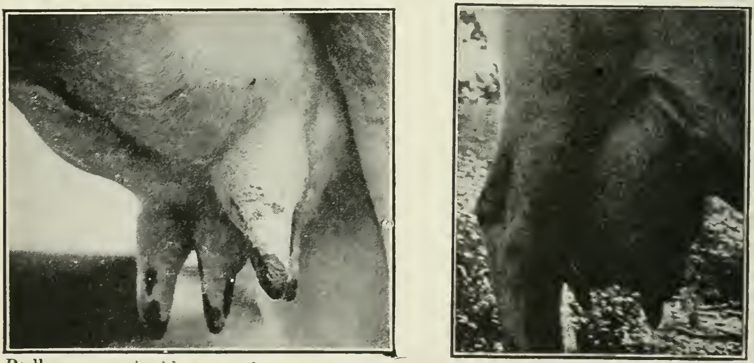
Poor rear development and short attachment to the body

Extremely small udder. Certain to be an inferior milker



A meaty udder. An inferior cow, not as good as her large udder indicates. She never exceeded 250 pounds of fat in a year.

Weak fore-udder. A common defect



Badly quartered udder; teats large and poorly placed. Such cows should be discarded

Pendulous udder. Most common in aged cows. Difficult to milk, becomes soiled easily, interferes with walking.

Fig. 11. Common udder defects. A well-developed udder is of first importance in selecting a dairy cow

tended; after milking it should be greatly reduced in size and show an abundance of loose skin and a soft, pliable texture. Fig. 10 shows fine examples of well-balanced udders.

The attachment to the body in the rear should extend well up behind. Special attention should be given the fore udder, as this part of the gland is especially subject to incomplete development. It should join the abdomen well forward, and be well up with the floor of the udder level. Fig. 11 illustrates defective udders. The quarters should be even in size, without deep indentations between. The teats should be of proper size for convenient milking, and evenly placed.

For show purposes especially, the shape and symmetry of the udder is particulary important. From the standpoint of production the essential thing is to have sufficient udder capacity to admit of the secretion of a large amount of milk, with teats of such size as to admit of convenient milking. When a cow is dry it is impossible to judge accurately of the development of her udder. However, a large number of loose folds of skin, showing an abundance of room for expansion when the udder is filled, may be taken as an indication that the udder will develop in a satisfactory manner. When judging a dry cow length of the attachment to the body should be especially noted. But little can be judged regarding the future size and shape of the udder in the calf or heifer until the time of calving approaches. The size and placing of the teats may be observed and judged with more accuracy than can the future development of the udder.

Other Features. Size and shape of the body, udder, and milk veins, are the most important points to consider in selecting dairy cows, but dairy type and temperament are also indicated elsewhere. Fine, clean-cut features about the face and head; wide muzzle and open nostrils; prominent, bright, active eye; long, thin neck, lacking thickness or coarseness at the throat, and joined smoothly to the shoulders; fine, smooth withers;

prominent and strong backbone; roomy pelvic region with hip and pin bones wide apart; thighs thin and incurving, with plenty of room between for udder development; and fine, clean bone throughout—all are features associated with cows of pronounced dairy temperament and large productive ability.

Breed Type. This term ordinarily embraces most of the foregoing characteristics indicative of temperament and capacity, and includes a number of other points which appeal to the eye, such as the long level rump, straight top lines, shapely udder, well dished or clean-cut face, and large, prominent eye. All these features are desirable, and are found in the good representatives of the various breeds, but they do not of necessity contribute anything additional to the productive capacity of the animal.

The Score Card. The score card, as applied to dairy cattle, is a concise description of the conformation of body desired with a numerical expression of the relative importance of each point considered. Perfection is, in most cases, represented by 100 points.

The first attempt to formulate a score card seems to have been made by the breeders of Jersey Island in 1834. About the time the importations of Holstein cattle to America began in the early seventies the breeders of Holland also published a scale of points for their cattle. The American Jersey Cattle Club first published a score card in 1889 and the Holstein-Friesian Association of America in 1885. In both cases these were modifications and improvements of those originally developed by the European breeders. The other breed associations later adopted score cards suited for their purposes. The score cards as now recommended by the dairy breed associations are found in the Appendix.

A study of the score card as adopted by the several breed associations reveals wide variation in the credit assigned certain points. For example, the Holstein score card gives 24 points to udder and milk veins, the Jerseys 38, the Ayrshire 35, and the Guernsey 22. Similar variations are found if other points are compared.

The student should bear clearly in mind that in formulating the score card consideration was not given to milk production alone. Breed type—that is, the conformation which is desirable from the standpoint of appearance—also received a considerable share of attention. It is clear in some cases that still another point was given attention. Certain breeds tend to be deficient in certain respects—for instance, the Jersey breed in the fore udder—and it was hoped that through emphasizing the value of such points by assigning a rather large value the deficit would be gradually eliminated from the breed.

As indicated, certain points of conformation—for example, the large development of the udder and barrel and a general evidence of using the feed for milk rather than for flesh production—clearly have to do with a capacity for milk production. On the other hand, there is no evidence that level rump and the dished face of certain breeds are correlated with milk production. These points are emphasized from the standpoint of appearance; having to do with a pleasing appearance they are none the less desirable, but it should be clearly understood that most score cards, especially those developed by the breed associations, look to both utility and beauty of form.

Use of the Score Card. While there is ample ground for a difference of opinion concerning the make-up of the score cards in use, their value—for the beginner particularly—is unquestioned. The use of the score card is especially valuable as a means of impressing the points to be taken into account and their relative importance. Their value decreases as experience is gained. Before using the score card the student should be familiar with the points of the animal as described in Fig. 12. After the student has progressed to the point of being reasonably familiar with judging, the score card is best discarded and the

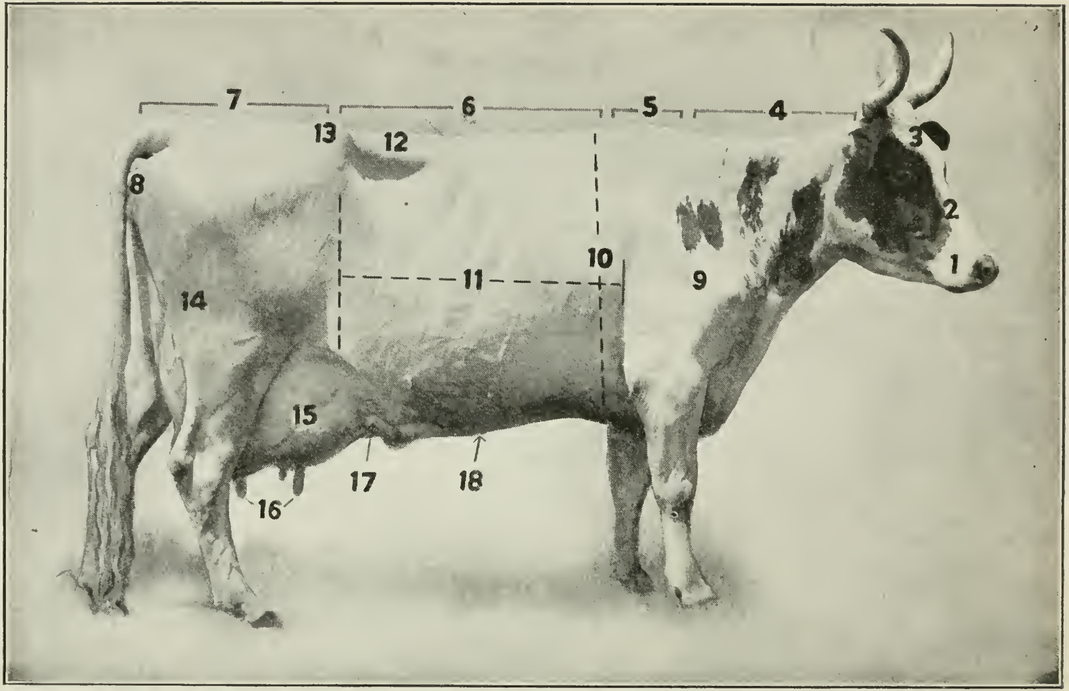


FIG. 12. Points of a cow. The student should know the descriptive terms used in judging:

1. Muzzle
2. Face
3. Forehead
4. Neck
5. Withers
6. Back
7. Rump
8. Pinbones
9. Shoulders
10. Heart Girth
11. Barrel
12. Loin
13. Hips
14. Thigh
15. Udder
16. Teats
17. Milk Veins
18. Milk Wells

judging done by comparison alone. Judging of cattle in the show ring is done entirely by comparison.

Since the essential facts concerning dairy type are much the same regardless of breed, it has been a common practice in teaching the judging of dairy cattle to make use of a general score card which aims to present the points of conformation indicating a high development of dairy quality regardless of particular breed characteristics. The beginner may well start with a score card of this type, making a study of dairy type in general. Later the breed score cards should be used and attention directed towards the points most emphasized. The score card given is an example of the class used for a study of the dairy type in general.

SCORE CARD FOR DAIRY COWS
(APPROVED BY THE AMERICAN DAIRY SCIENCE ASSOCIATION, 1922)

SCALE OF POINTS	Perfect Score	Percent Cut	Students' Score	Corrected
I. Characteristics Indicating Dairy Form				
A. Style and general appearance—20 points				
1. Head erect, clean cut; neck slender, eye prominent, alert and placid.	3			
2. Back—straight and strong, hips wide apart and level	4			
3. Rump—long, wide and level; thurl wide apart and high; level tailsetting	5			
4. Legs—straight, bone fine . . .	3			
5. General build—rugged and large for the breed without coarseness; Jerseys 950 lbs., Guernseys and Ayrshires 1,100 lbs., Holsteins 1,350 lbs. . . .	5			
B. Dairy Conformation—15 points				
6. The cow should be clean cut with feminine appearance; absence of tendency to lay on fat . .	5			
7. Shoulders, withers, vertebræ, hips and pin bones prominent and free from fleshiness. (Period of lactation to be considered) . .	4			
8. Loin wide, ribs long and wide apart	3			
9. Disposition active, with good nerve control	3			

Score Card for Dairy Cows, continued

Scale of Points	Perfect Score	Per cent Cut	Students' Score	Corrected
II. Characteristics Indicating Constitution, Vigor and Condition—15 points				
10. Chest—broad and deep with well-sprung ribs	8			
11. Nostrils—large and open . . .	2			
12. Condition—thrifty and vigorous, in good flesh but not beefy . .	5			
III. Characteristics Indicating Ability to Consume and Digest Feeds—15 points				
13. Muzzle large, mouth broad . . .	1			
14. Skin mellow, loose, medium thickness showing good circulation and secretion, hair soft . . .	4			
15. Barrel—deep, wide and long, well supported, ribs far apart . .	10			
IV. Characteristics Indicating Well-Developed Milk Secreting Organs—35 points				
16. Udder:				
a. Capacity—large in size . .	7			
b. Quality—pliable, free from lumps	7			
c. Shape—extending well forward and well up behind, level on floor, not pendulous, quarters full and symmetrical . .	6			
17. Milk veins—large, long, crooked and branching; milk wells large and numerous	7			
a. Milk veins on udder crooked, numerous and large	3			
18. Teats—convenient size, uniform and well placed	5			
	100			

Note: In case of any marked deficiency or any serious abnormality, as many as fifty points may be deducted from the total score of an animal. Beware of giving a thin beef cow as good a score as a dairy cow.

CHAPTER IV

HOLSTEIN-FRIESIANS

Origin and Distribution in Europe. This breed originated in Holland, and more especially in the province of Friesland. It is not, as the name would indicate, native to the duchy of Holstein, which is a province in North Germany. The compound name Holstein-Friesian, the official name of this breed in America, resulted from a union of the Holstein Breeders' Association and the Dutch Friesian Association in 1885. In common usage now in America the breed is called Holstein.

The ancestor of the breed, according to Kellar, was the *Bos Primigenius*, the wild ox of Europe. The breed is one of the oldest in existence. Historical references indicate that these cattle have been bred in the same region for at least 2,000 years, and probably there has been very little, if any, mixing with outside blood. In the time of Cæsar the region now part of Holland was famous for its cattle. In the ninth century Holland was well known for its cheese and butter. According to Motley, Holland in the seventeenth century exported annually large quantities of butter and cheese, and was noted for its immense oxen. This reputation has been maintained ever since, and during all these centuries cattle rearing has been almost the exclusive business of the Holland farmer. Today no fruit is grown, and very little grain. The caring for cows, the growing and preparing of feed for them, and the utilizing of milk for butter and cheese manufacture monopolize the attention of the farmers.

The Holstein-Friesian breed is best developed in its native home, the province of Friesland and across the Zuyder Zee in North Holland. It has been the parent stock of several others, which through local influences have been somewhat modified from the original. Most prominent among these descendants are the Oldenburg, East Friesian, East Prussian-Holland, and the Flanders of Belgium.

The Holland cattle, or their descendants in these latter mentioned sub-breeds, are now distributed over a large portion of North Europe, extending into Russia. In the seventeenth and eighteenth centuries Holland cattle were taken to England, where, according to Professor Low, the eminent English authority, they were a factor in the formation of the Teeswater or Shorthorn breed, from which our modern improved Shorthorns are descended. It is also believed by good authorities that Holland blood was an important factor in the foundation stock from which the present Ayrshire breed is descended.

Conditions in Holland. The best part of Holland lies almost entirely below the level of the sea, which is kept out by enormous dykes. The land is very fertile, and is almost exclusively used for growing grass. The farmers, who are mainly tenants, pay from $30 per acre upwards annual rent. The land, which is seldom bought or sold, is valued at from $800 to $2,000 per acre.

In no other part of the world does the cow receive such careful attention as in Holland. About the first of October the cattle are placed in the stable, which is often separated only by a door from the living room of the family, and remain there, constantly as a rule, until the first of May. The stables and the cows are kept in a condition beyond criticism from a sanitary standpoint. If an animal becomes soiled with manure, she is washed and cleaned carefully before milking. The feed is mostly hay, with a small allowance of linseed or other cake.

In the summer season the cattle are kept on the pastures and not brought to the barn. The milkers carry the milk from the pasture rather than fatigue the cows by driving them. If a cold wind blows up, the cows are at once blanketed in the pasture. Great care is taken in raising stock only from the best animals. Only a few bulls and about one-fifth of the heifers are raised, and these from the best milkers only. The surplus calves are sold for veal, and the cows as a rule are sold for beef at an age of eight or nine years. In Friesland the milk is used largely for butter making and in North Holland mostly for cheese making.

Importations and Distribution in America. A few Holsteins were imported as early as 1795, but were not kept pure. The first importations that were kept pure were made into Massachusetts in 1861.[1] Only a few were brought over before 1875; but between this date and 1885 about 10,000 were imported, and from these are descended most of the animals of this breed now in America. The only animals imported since 1885 were a few in 1903. The explanation of the small number imported since that date is the high fee required by the Holstein-Friesian Association for registering imported animals and the prevalence of foot and mouth disease in Holland, which has resulted in a quarantine most of the time during the past thirty-five years.

The 1920 census showed a total of 531,725 head of registered animals of this breed in the United States. The five leading states in numbers at this time were New York, Wisconsin, Pennsylvania, Ohio, and Michigan. The numbers in the southern states is limited. The distribution of grades of this breed, as with other breeds, coincides with that of the pure breds. There are entire counties in New York and Wisconsin where few animals of any other breed are to be seen.

The first breed association, known as the Holstein Herd Book Association, was organized in 1873, and five years later the Dutch Friesian Association was formed. In 1885 the two united under the name Holstein-Friesian. The registration of Holsteins has increased with great rapidity in recent years.

---

[1] Houghton, F. L., *Holstein-Friesian Cattle*, p. 17, (1897).

Up to 1921 the total number registered was a little over one million. Of these about one-third were bulls. Registration is progressing at a rate of over two hundred thousand yearly.

Size and Type. The Holsteins are the largest of the dairy breeds. The average weight of the mature cow is 1,250 pounds, although individuals vary from 1,100 to 1,800 pounds. The bulls vary, as a rule, from 1,800 to 2,200—occasionally an individual reaches a weight of 2,500 or even more. The tendency in recent years seems to be toward a somewhat larger type. The tendency has been encouraged by the fact that the cows holding the largest official records are in practically every case far above the average of the breed in size. Some of the best known cows of the breed in recent years have weighed 1,800 or in a few cases over 2,000 pounds.

In the description found in the early volume of the Advanced Register of this breed, the cows are classified according to form as follows:

Milk and Beef Form
Milk Form
Beef and Milk Form
Beef Form

This form of description is little used now. It was arranged for use in examining cows for admission to the Advanced Register by inspection. Cows are now admitted by an official test, and no description is required. The milk and beef form is the type of most of the imported cows, and the prevailing type. They have the wedge shape, but not especially pronounced; the shoulders are rather thick, deep, and broad. The barrel is round, the hips and loin broad and full. The quarters are straight and rather full.

The milk form is more angular in general appearance; the shoulders are thinner, and the wedge shape is more pronounced, the loins and the hips are broad, the thigh is thin and incurving. The other two divisions of the classification are seldom used, but they indicate a more pronounced tendency towards flesh production.

On the average the cattle of this breed, as found in Holland, show somewhat more of a beef type and a less pronounced dairy type than those found in America. The Holland farmer generally sells his cows for beef while they are still comparatively young, and he also expects a considerable income from veal production. For these reasons he insists on some meat-making capacity. The Holsteins brought to America have generally been those having the best developed milking indications, since their reputation in America is based upon their milk-producing capacity.

The opinion has been expressed by some authorities that the type of this breed in America has changed since it was first introduced. Those claiming to recognize a change attribute it to the fact that the judges at the American shows usually have a prejudice in favor of rather extreme dairy type, brought about by familiarity with other breeds or as a result of agricultural college instruction. There is evidence that this tendency was apparent for a period of possibly twenty years preceding 1915. About this time, as a result of agitation by Holstein breeders, more care came to be given by show ring judges to recognize the true Holstein type and to avoid the judging of all breeds according to the same standard. This tendency to judge all dairy cattle by one standard, and especially attempting to apply to the larger breeds an ideal of refinement in form based largely upon the smaller breeds, is a mistake which the agricultural college student must take special care to avoid.

It is probably safe to say that the typical Holstein as now bred in America is slightly smaller than the Holland animal, and a larger proportion have pronounced dairy type. The color markings are variegated black and white. As a rule the breeders have preferred animals on which the two colors are about evenly divided The colors are always sharply defined

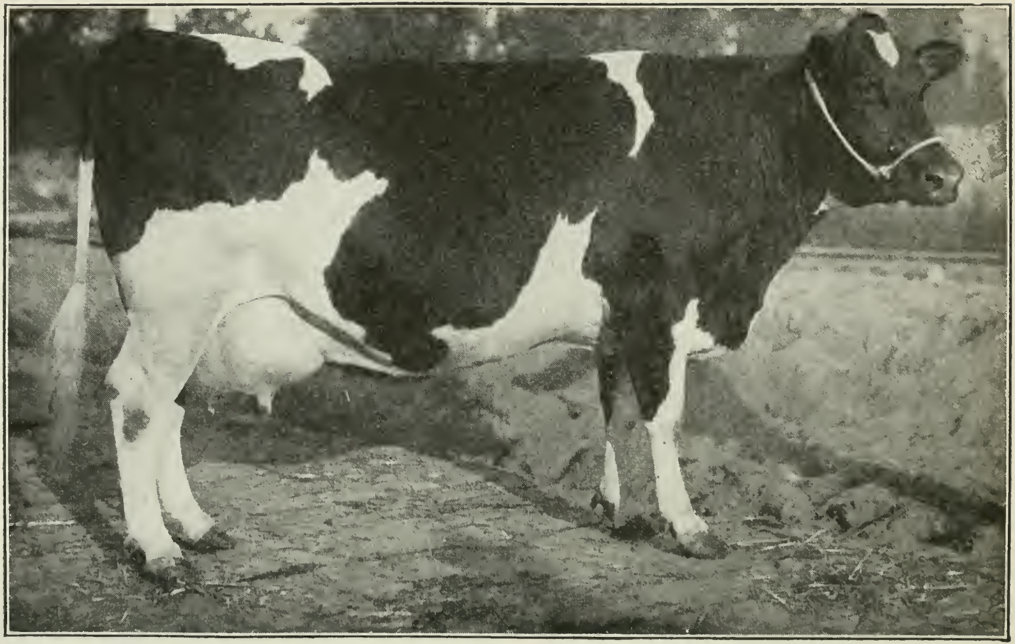


Fig. 13. Holstein cow, Lady Aaggie Ormsby of Rock. She combines type and production to a high degree. Champion at Pacific International Show, 1921. Official record, milk 29,805 lbs., fat 855 lbs.

and not blended. Fortunately this breed has never been injured by a color fad, although in recent years there has been some tendency to favor those having more white than black.

Among the cattle of that part of Holland from which the ancestors of the Holstein-Friesian breed of America came are a small number with red and white markings in place of black and white. These animals are not discriminated against so far as registration in Holland is concerned, although the Holland breeders, especially in recent years, have preferred the black and white, and for this reason the red and white has decreased to a point of practical elimination in registered herds. The unregistered herds, numbering about 80 per cent of the whole, still show up to 10 per cent of red and white. Registration in the herd book of the Holstein-Friesian Association of America is open only to those having black and white markings. However, it is not uncommon for a red and white calf to be dropped that is unquestionably the offspring of pure-bred black and white parents. Bulls are occasionally reported that transmit these markings to a considerable proportion of their offspring. Such a case is no reason for raising a question concerning the purity of the breeding of the bull in question.

Breed Characteristics and Adaptations. As a breed, the Holsteins have the best disposition or temperament of any dairy breed. In this respect they resemble the Shorthorns more than any other breed. While cows of the breed as a rule have plenty of nervous energy, which is necessary to high dairy production, they are not nervous in the common meaning of that term. Where Holsteins and other more excitable breeds are kept together, the contrast is easily noticed. A change of milkers, or any sudden disturbance, as the presence of a stranger or a dog, will produce little or no effect on most Holsteins, while cows of some other breeds will show a marked change in milk production. The Holstein is less alert and active than the other dairy breeds, but her nerves are well under control. This

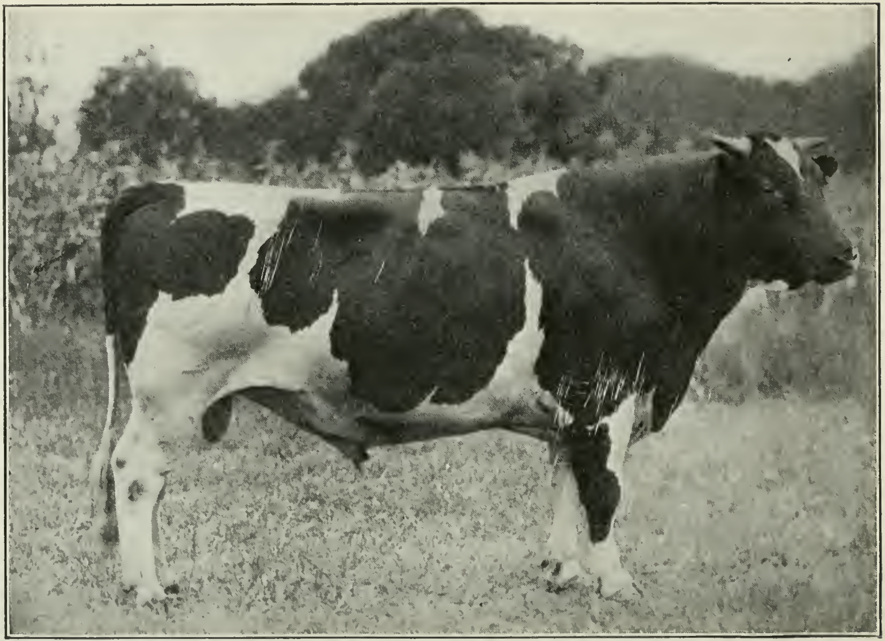


Fig. 14. Holstein bull, Sir Pietertje Ormsby Mercedes 14th. A show-ring winner and the sire of 20 cows in the Advanced Register

is of considerable advantage on account of the usual necessity of having dairy cattle handled by men more or less careless and inefficient.

The Holstein cow is best adapted for rather level, rich pastures, and where liberal feeding is practicable. As grazers on hilly or scanty pastures the breed is easily surpassed by the Jersey and Ayrshire—especially the latter.

The reproductive function of cows of this breed is good, being equalled among dairy breeds only by the Brown Swiss. Considerable trouble with sterility and shy breeding is experienced with all highly developed breeds, but the Holstein gives as little trouble as any in this respect. The calves are large, weighing, on the average, 90 pounds at birth; and they are strong and vigorous, giving the minimum trouble in raising. At birth the Holstein calf is the largest of all breeds except the Brown Swiss, and on the average it represents 8 per cent of the weight of its mother. The Jersey calf, on the other extreme, averages 6.5 per cent of its dam's weight.

As beef producers, the breed ranks high for a dairy breed. As in the case of the other dairy breeds, the gains in weight are made as rapidly and as cheaply as by animals of the beef breeds. The market price for Holstein steers is generally lower than for animals of the beef breeds, perhaps partly as a result of prejudice, but mainly—as is the case with the other dairy breeds—on account of the lower dressing weight, the smaller proportion of high-priced cuts, and the greater amount of offal fat.

The calves are especially well adapted for veal production on account of the large weight at birth and the rapid gains made during the first few weeks.

The Holstein does not withstand hot weather as well as some other breeds do. This fact is readily observed where cows of this breed and of others are kept under the same condition in a rather hot climate. The ability of other breeds such as the Jersey to endure heat better than the Holsteins undoubtedly has some relation to the fact that the Jersey is the leading breed in the southern part of the United States and the Holstein in the northern part.

The breed does not mature especially early. The animals reach the maximum of growth in skeleton between the ages of four and five years, while the maximum weight is reached about two years later. Usually the heifers are sufficiently mature to come into milk between 28 to 30 months. Freshening at an earlier age is not advisable, as the tendency is to check growth and to result in undersized cows.

Milk and Fat Production. No satisfactory statistics are available which show the average production of any of the dairy breeds under practical farm conditions. An abundance of data may be had which give results from official testing, but the value of such records is limited as a criterion for judging results under conditions such as exist on farms where the bulk of the milk supply of the country is produced. On the other hand, figures of production by herds on average farms, while of value, would not be satisfactory as indicating the capacity of a breed to produce milk and fat, since in too many cases the low production shown by such figures is due largely to poor feed and management and does not, therefore, represent the real capacity of the breed.

A compilation of published yearly records of cows owned by Experiment Stations shows an average annual production by cows of the Holstein breed of approximately 9,000 pounds of milk containing 3.45 per cent of fat, and an average yield of 310 pounds of fat. These figures are fairly representative of average yield under good conditions. The most valuable figures would probably be those representing entire herds on farms where a reasonable amount of culling of inferior animals is done; where the cows are well fed, but not pushed by excessive grain feeding to the point of lowering the economy of production, and are bred to calve at intervals of twelve months. Under such conditions in a Holstein herd, an average of at least 8,500 pounds of milk and 290 pounds of fat should be expected each year for all cows in milk, including animals of all ages.

Occasionally an average of 10,000 pounds is reached under such conditions for a term of years for an entire herd, but this is unusual and represents exceptionally well-bred animals with unusually good methods of feeding and management. On the other hand an average of less than 7,500 pounds should cause the owner to examine most carefully into his methods of selecting and feeding. The average fat percentage for the herd will not vary much in any case from 3.45, the average for the breed.

Characteristics of Holstein Milk. The Holsteins produce more milk, on the average, and at a cheaper cost for 100 pounds, than any other breed. The per cent of fat averages the lowest. It is also claimed by some breeders that the per cent of fat has been increased by American breeders. While it is possible that the strong efforts now being made in this direction by the leading breeders has resulted in richer milk from certain herds of selected animals, there is no evidence to show that the average of the breed has been changed. Data based upon seven-day official tests is of little if any value in this connection, and the results of yearly tests show almost exactly the same average percentage of fat as was reported in the beginning of official testing.

It sometimes happens that the milk from a heavy producing herd, especially when the majority of the cows are fresh, will fall below the usual legal standards in both fat content and percentage of solids not fat. This may be remedied so far as the fat percentage is concerned by standardization. When the fat is lower than desired, a portion of the milk is run through a separator and the cream added to the remainder of the milk. The proportion of the total to be separated may be determined by calculation or by the use of a formula for the purpose in common use. In case it is desirable to lower the fat content the skim milk separated rather than the cream is added to the remainder of the milk.

There is a tendency to criticize the Holstein unduly on account of the well-known low fat content of the milk. If butterfat is marketed the total quantity produced is the most important fact. It has long been known from practical experience that milk with an unusually high fat content is not as desirable for calf feeding as is milk with an average, or even a lower, percentage of fat. This belief on the part of practical cattle men has been confirmed in recent years by research work both with man and animals.

The total solids of Holstein milk contain on the average 28 per cent of fat as compared with 34 per cent for the Channel Island breeds. This fact is of some importance in connection with the question of the relative economy of fat production by different breeds as discussed in another paragraph.

The fat globules are small, rather variable in size, and show the least yellow color of any of the breeds. On account of the small size of the fat globules, the cream does not separate so quickly nor so completely by gravity as is the case with larger fat globules. However, when a centrifugal cream separator is used the difference in the loss of fat in the skim milk from different breeds is too small to deserve consideration. The lack of color in the fat results in the milk and cream showing much less color than if it were of equal quality, but the product of a Jersey or Guernsey. The lack of color is of some disadvantage in selling market milk or cream, since in the popular mind a yellow color is considered an index of richness.

The small fat globules are of some advantage when the milk is to be transported to market, as it makes possible the necessary handling of the milk with the minimum of churning.

Families. There are no well-defined families among the Holsteins, as is the case with some other breeds. Holstein breeders often refer to certain animals in a way that would suggest a family—for example, speaking of a De Kol, a Johanna, or a May Echo Sylvia. Such a statement indicates that the animal in question is a descendant of the noted animal mentioned. Unlike the Jersey breed, in which the families are as a rule traced to a bull as progenitor and who gives the family its name, the Holstein breeders trace their lines of breeding ordinarily back to a great foundation cow. A foundation cow is one that transmits characteristics desirable for that breed to a high degree. In most cases the exceptional qualities of such animals are not recognized until their days of usefulness are long past.

The breeders of Holstein cattle have followed the practice of the Holland breeders and have had something of an aversion to in-breeding and, until recently, even to line-breeding. Without line-breeding and more or less in-breeding it is impossible to establish a real family within a breed.

During the early development of the breed in America, certain cows rather than bulls were given prominence in Holstein breeding operations. This is still true although not to the same extent. Cows with large official records, and their descendants, are in the greatest demand although, since a large number of official records have been recorded, the value of certain bulls as sires of high producing cows has been more fully recognized, and as a result bulls of high transmitting ability are in great demand and their descendants are much sought after.

Advanced Registry. The Advanced Registry has been one of the important factors in the increase of popularity of this breed in America. The Holstein-Friesian Association, and especially Mr. S. Hoxie of Yorkville, New York, should be credited with the introduction of this system—since adopted in somewhat different forms by other dairy cattle associations in America. The plan is to make record of dairy performance, in addition to regular registration.

The first entries were made in 1886. Under the original plan the animals were admitted on making certain milk and butter records as the result of tests made and reported by the owners themselves, and after an inspector had scored and examined the animal. This association was the first to adopt the Babcock test as their official method, which was in 1894. At first they adopted the plan of printing the records in the form of butter, calculated on the basis of 80 per cent fat. Later the rules were changed, and since that time the test supervisor reports the milk and fat yield. The common practice, however, on the part of Holstein breeders is to express the results in terms of butter, calculated on the 80 per cent fat basis. A 1,000-pound cow, as the term is used in breed literature, means one that produced 800 pounds of fat in a year, and a 30-pound cow one that produced 24 pounds of fat in seven days. In all cases it is assumed that the record was made under official test supervision.

The test period may be of any length from seven days to twelve months. The most common test periods are for seven days, thirty days, 305 days, and 365 days. The term "official test" is used to designate those made where the supervisor is present throughout the period, as is always the case in those covering seven days or thirty days. Those covering 305 days or 365 days are spoken of as "semi-official." In this case the supervisor is present and takes the weights of milk and makes a fat test of each milking for a period of two days each month. The milk record for the remainder of the month is kept by the owner. The average fat percentage for the two days the cow is under supervision is taken as the average for that month. If the cow reaches or exceeds the minimum fat requirement for her age she is given a number and entered in the Advanced Registry. When the test is for a short period and is made under complete supervision as indicated, the cow is spoken of as an A.R.O. cow, the abbreviation standing for Advanced Registry Official. When the test is semi-official, the abbreviation placed in the pedigree often is A.R.S.O.

The minimum requirements for admission to the Advanced Registry are the following:

Seven-day test. A heifer calving at the age of two years must produce 10 pounds of fat in seven days. For each day of age above two years at the date of calving, the requirement is increased .0055 pound of fat over the requirement for admission at the age of two years. At five years of age the cow is assumed to be mature. The requirements for the even years are given below:

2 years old	10 lbs. of fat
3 years old	12 lbs. of fat
4 years old	14 lbs. of fat
5 years old	16 lbs. of fat

365-*day or yearly test.* Beginning at the age of two years the requirement is 318 pounds of fat in the twelve months with an addition of .148 pound of fat for each day in age beyond two years at the time the test is begun. No requirement is made regarding time of next calving.

2 years	318 lbs. of fat
3 years	372 lbs. of fat
4 years	426 lbs. of fat
5 years	480 lbs. of fat

A cow failing to meet the calving requirements in the 305-day test is eligible for the yearly record.

305-*day test.* The requirement in this class is 85 per cent of that for the 365-day test, with further provision that the cow must give birth to a living calf within fourteen months from the date the record was begun. Cows meeting all requirements for the 305-day and the 365-day tests in the same lactation period shall be credited with both records.

Entry of bulls. A bull is eligible for Advanced Registration when four of his daughters qualify for Advanced Registration in any of the classes.

Summary of Advanced Registry Results. Table 7 gives the results for the several classes in the long time tests up to April 30, 1922.

TABLE 7. SUMMARY OF OFFICIAL TESTING RESULTS—HOLSTEIN BREED

CLASS	NUMBER ANIMALS	LBS. MILK	LBS. FAT	PER CENT FAT
Over 5 years	4,362	17,182	585	3.41
4½ to 5 years	883	16,321	551	3.38
4 to 4½ years	956	15,593	531	3.41
3½ to 4 years	1,095	15,111	510	3.39
3 to 3½ years	1,172	14,269	483	3.39
2½ to 3 years	1,403	13,852	470	3.39
2 to 2½ years	2,238	12,882	439	3.41
Average	12,110	15,344	521	3.40

Up to 1922 over fifty cows of this breed have made records of 1,000 pounds of fat or more in a year. The highest records for fat production up to 1923 are:

	LBS. MILK	LBS. FAT
May Walker Ollie Homestead	31,610	1,218
Duchess Skylark Ormsby	27,761	1,205
Finderne Pride Johanna Rue	28,403	1,176
Segis Pietertje Prospect	37,381	1,159
Adirondac Wietske Dairy Maid	34,401	1,136
Neeltje Mercedes De Kol Homestead	30,565	1,134

Agassiz Segis May Echo, a Canadian cow, is credited with 30,102 pounds of milk and 1,338 pounds of butter fat in a year.

Quite a few cows of the breed have exceeded 30,000 pounds of milk in the year. Among the highest up to 1923 are:

	Lbs. Milk
Segis Pietertje Prospect	37,381
Kolrain Marian Finderne	35,339
Queen Carlotta De Kol	34,430
Tilly Alcartra	33,425
Maud Netherland Wayne De Kol	32,632
May Walker Ollie Homestead	31,601

CHAPTER V

JERSEYS

Origin and Distribution in Europe. The Jersey and the Guernsey breeds are often called the Channel Island breeds. They take their names from the islands of the same names, which are a part of the group called the Channel Islands. This group, which includes the Islands of Jersey, Guernsey, Alderney, and Sark, lies in the entrance to the English Channel about nine miles from the coast of France and about seventy from England.

The cattle from these islands were formerly classed together and called Alderney, after the third island in size of the group. The cattle on these islands are supposed to be descendants of the cattle of Normandy and Brittany in France. According to Kellar, they belong to *Bos sondaicus* type, and are therefore related in origin to the Brown Swiss, the Devons, the Kerry, and more or less to other cattle of England, but not to the Holsteins. When they were brought from France to the Islands is not known, but it is known that they have been kept pure for a very long time. Since 1789 a law has been in force on Jersey Island which entirely prohibits the importation of cattle except for slaughter. A few years later Guernsey adopted a similar law.

Outside of Jersey Island the Jersey breed is found quite numerous in England, but only a few are used elsewhere in Europe. The first demand for them outside of their native island came from England; where they were placed on the estates of the nobility largely on account of their beauty. Even to the present time the breed has not contributed very much to the total dairy products of England.

Conditions on the Isle of Jersey. Jersey Island is eleven miles long and about nine wide. Its area is 36,680 acres, of which 25,000 are tillable. The population is about 60,000. This island rises from the level of the ocean on the south, in a long gradual slope to the north side, which has cliffs about 200 feet high along the ocean. The climate is mild and even. The grass remains green throughout the year and is rather fine and nutritious. The cattle are pastured during the day by the tethering system. From May to October the cows, as a rule, remain outdoors all the time. In winter the cows are out in the daytime, and in the evening they are housed and fed hay, roots, and a small ration of bran, or oil cake. But little grain is fed at any time.

At least two crops of some kind are raised each year on the same land. The average annual rental is over $50 per acre, including the ground occupied by the dwelling-house and barn as well as for the cultivated land. The Island was at one time in a very low state of fertility, but its productiveness has been increased until it ranks among the highest developed agricultural regions in Europe. About 10,000 cows are kept on the Island, or one to every 2.2 acres of cultivated land.

The cattle have been bred and improved with special reference to butter production for over 100 years. In 1834 a scale of points was made out for both cows and bulls, and prizes were offered for the animals conforming most nearly to the scale of points. The breed began to improve more rapidly from that time on. At the present time the cattle on the Island are a very uniform lot, but their average production is probably lower than that of equally good representatives of the breed in America, largely because they are fed a less liberal ration of grain, and they average smaller in size than American Jerseys.

Registration on the Island. The plan of registration of cattle on the Island is quite different from that followed in America. Cows are registered as Pedigree Stock and as Foundation Stock; bulls as Pedigree Stock only. Within twenty-four hours after the birth of a heifer calf which is to be registered, the owner must notify a member of the Agricultural Department, who issues a certificate showing the calf is from the cow claimed. This certificate, with one from the owner of the sire, is filed with the Secretary of the Register within six months. This is called preliminary registration.

Every two months examinations are held for the qualification of these registered cattle. The cattle to be examined are taken to the appointed place and examined by the judges. If the heifers meet with the approval of the judges, they are given qualification C.; if commended, or if of exceptional merit, they are given qualification H.C., high commended. Cows in milk which are not registered under the first qualification may be examined for foundation stock, and if passed, are registered with the others. When a bull comes up for examination, his dam must be shown also, and her qualifications are taken into account before registering the bull. Animals passing these examinations are given herd book numbers.

A system of official testing for milk and butter fat production, modeled after the Register of Merit of the American Jersey Cattle Club, was adopted several years ago, but official records have not yet attained the prominence which they hold in this country. The system of registration which is followed has resulted in making the Island animals a strikingly uniform and beautiful lot.

Importations and Distribution in America. In 1850 several Jersey cows were imported to Hartford, Connecticut, and in 1868 S. S. Stephens of Montreal, Canada, imported nine animals, from which have descended some of the most famous producers in the Jersey breed. After 1868 importations were numerous until about 1890, then followed a period of several years when few were imported. During the last decade several importations have generally been made each year. The interests of the breed in the United States are looked after by the American Jersey Cattle Club. Something over one million animals have been registered in the United States up to the middle of 1922, of which about one-fourth are bulls. About 125,000 animals are now being registered annually.

The census of 1920 showed a total of 225,912 registered animals of this breed in the United States which ranks the Jerseys second in numbers among dairy breeds. The Jersey is found in all parts of America, but most numerous in the eastern and southern states. According to the census figures the five leading states in numbers are Ohio, Texas, New York, Pennsylvania, and Missouri. The breed is making rapid progress on the Pacific Coast, especially in Oregon. The popularity of the breed has been helped by the fact that it was introduced at an early date and further by the skill shown by the American Jersey Cattle Club in looking after its interests.

At an early date this breed was afflicted by a color fad, which injured it somewhat for several years. The fad was for solid colors, which means no white markings, and for a black tongue and switch. At present little attention is paid to color, although the majority of the Jerseys found in this country have the solid colors and black points. In the late seventies and early eighties a great boom struck the breed in the United States. Cows of the St. Lambert breeding brought enormous prices. As high as $25,000 was paid for a single cow. In 1893 twenty-five animals each of the Jersey, Guernsey, and Shorthorn breeds competed in a dairy test at the World's Fair, Chicago. In both the production of cheese and butter the Jerseys won first place on total production and economy of production. This gave the breed greatly increased popularity, and their numbers increased very rapidly in the following years. They also stood first in the dairy test at the World's Fair in St. Louis, in 1904, with the highest average production and the greatest economy of production of butter fat.

Size and Type. The Jersey is the smallest of the dairy breeds, with the exception of the Kerry. The weight of the average cow is generally between 800 and 900 pounds. The bulls, as a rule, range from 1,200 to 1,700 pounds. The breeders in America have generally favored the larger animals, and for this reason, and possibly also on account of the more liberal feeding practiced, it is generally believed the breed tends gradually to increase in size after a few generations in America. Cows weighing 1,000 pounds are quite common here, but unknown on the Jersey Island.

A good Jersey cow is the model of what is generally taught to be the dairy form. She has the pronounced wedge shape, an immense barrel for her size, and a well-developed udder, and she does not carry a pound of surplus fat while in full flow of milk. The difference is so marked between the imported, or their near descendants, and those descended from the early importations that the two types are generally recognized as the American and the Island types. The American type is well represented by animals of the St. Lambert breeding. More recently the Sophie's Tormentor, St. Mawes, and Golden Glow families have gained prominence as American bred families. This type is larger and coarser than the Island type, and less beautiful; and it is often deficient in fore udder development, it is inclined to coarseness in the head and pelvic region, and often lacking in general symmetry. Cows of the American families have so far held most of the milk and butter-fat records for the breed.

The Island type is small and delicate-looking, beautiful in form, and splendidly developed in the udders, especially in front. They have fine symmetrical heads and necks, and level, flat rumps. They have been the favorites in recent years in show ring competition, and have included the most fashionable breeding and highest priced animals of the breed.

Influence of the Early English Breeders. The Jersey breed and the practices of the Jersey breeders have been influenced more by Philip Dauncey than by any other individual. Dauncey began his breeding operations in 1826 and first made the breed well known in England through his remarkable breeding operations, which covered 41 years. His ideal was to develop large, rather coarse animals of great constitution and with remarkable milking qualities. W. G. Duncan began his breeding operations in 1849, making use of the Dauncey blood, and continued the development of the same type, which is that now known in the United States as the American type. In developing the type these breeders selected animals of the type they desired, and then inbred freely and continuously. They also bred heifers to calve at three years of age, which was an important factor in developing a large animal. The early importations to America were largely cattle from the Duncan herd, or were descendants of the Dauncey herd. These facts show that the ancestors of many American herds were taken from Jersey Island nearly a hundred years ago and that the origin of the so-called American type of Jerseys should be mostly credited to Dauncey and Duncan. It is also interesting to note the influence Dauncey's practices still has upon American breeders. He practiced in-breeding persistently and the practice has been followed by breeders of this class of cattle ever since, although it has never been adopted to any extent by those interested in other dairy breeds. The fad for solid colors, once so strong in America, and which still persists to some degree, originated with these two English breeders.

Breed Characteristics and Adaptations. The color of the Jersey varies greatly. It may be any shade of yellow, except orange, from almost white to very dark squirrel gray or black. The most common color is fawn with black shadings below and on the head. White spots may appear most commonly on the underline, but they are not generally looked upon with favor, especially among breeders of the American type. The tongue and switch are generally black. The muzzle is intensely black, encircled by a light-colored ring. The bulls are as a rule darker in color than the cows.

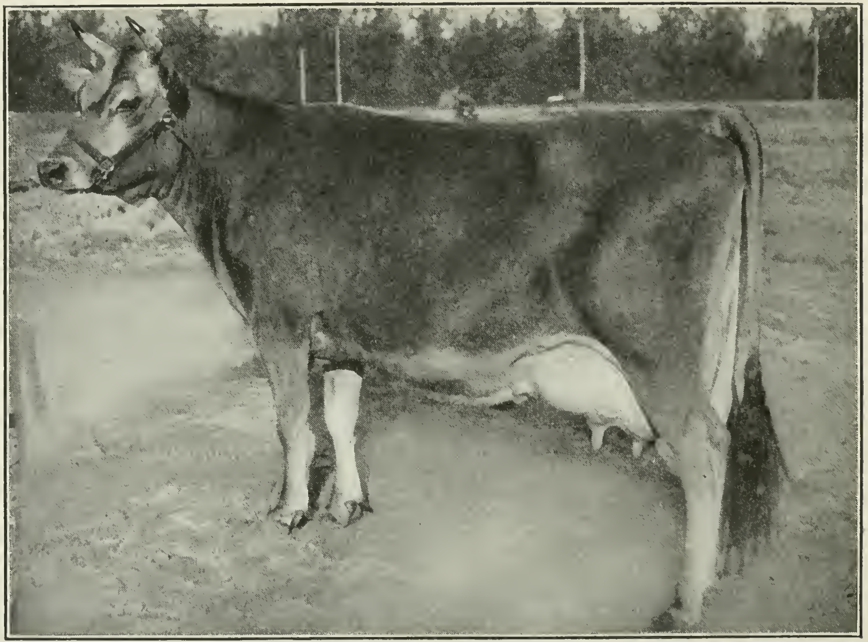


Fig. 15. Jersey cow, Rinda Lad's Lady. She represents an excellent combination of dairy type and production. Champion at Pacific International Show, 1922. Official record: 940 lbs. fat.

Cows of this breed are quite sensitive, on account of having a highly developed nervous temperament which is not very well under control. When carefully handled, they become exceedingly gentle. On the other hand when carelessly handled or abused, they become very much the reverse. They are more easily disturbed by unusual surroundings than other dairy breeds.

Jerseys are easy keepers; but like all dairy animals, they need good pastures and liberal feeding for good returns. They do better than the Holsteins on rough and scanty pastures, but they are not equal to the Ayrshire in this respect. They seem to thrive in warm southern climates better than some other breeds.

As meat producers they stand low, even for dairy breeds. The body fat is very yellow and is not well distributed. The calves are small, weighing between 50 and 60 pounds at birth, and do not gain rapidly for the first few weeks. For this reason they are not well adapted for veal production. If Jersey calves are raised for meat, they should usually be sold by the time they are eight or ten months old.

The breed is very prepotent when crossed upon common cattle or grades of other breeds. The cross usually partakes strongly of the Jersey type and milking qualities. The heifers mature young. They are usually sufficiently well developed to come into milk at the age of 24 to 26 months. The lack of vigor in the calves at birth and the mediocre breeding qualities of the cows are generally considered the weakest points of the breed.

Dairy Characteristics. Under good farm conditions an average yearly production of 5,500 pounds of milk and 275 to 300 pounds of fat including all females of milking age would be considered fair results. An average of 8,000 pounds of milk, or more, would be unusually high, but is obtained under the best conditions. The fat percentage varies between 4.5 and 6.5 with an average of about 5.0. The total solids are high in keeping

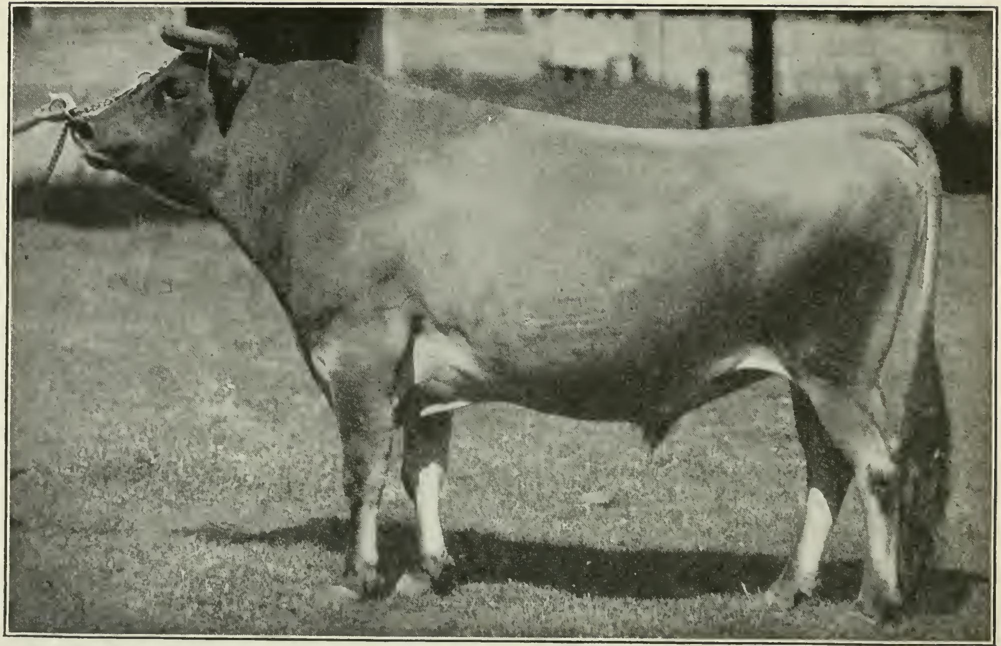


Fig. 16. Jersey bull, Pogis 99th, of Hood Farm. An outstanding bull of the breed. Sire of 99 cows in the Register of Merit; of these 41 have records of over 600 lbs. fat in a year

with the fat content, averaging 14.9 per cent. The fat on the average constitutes 34.5 per cent of the total solids as compared to 28 per cent for the Holsteins.

In quantity of milk the Jersey breed is excelled by several others, but in fat yield it ranks equal to any. On account of its richness Jersey milk can not be produced and sold in competition with that from other breeds where weight or quantity is the basis of payment. Even where milk is purchased for market purposes or for condenseries it is often the practice to pay a price per hundred for milk with a minimum fat content, usually 3.5 per cent, with a small increase for each tenth of a per cent or "point" above 3.5. The price paid for the fat above the minimum is less than that for the basal amount and this works a discrimination against the cow giving the high-testing milk. For these reasons the Jersey or Guernsey are not used to any great extent in localities marketing whole milk.

As an economical producer of butter fat the Jersey and her near relative, the Guernsey, are unsurpassed. The Jersey milk has the highest per cent of fat of any dairy breed common in this country. In economy of production of fat this breed has always led, where opportunity has been given to make fair comparison with other breeds. The economy of fat production by these breeds, as explained elsewhere, is to be attributed to two factors. One is the fact that the fat represents a greater proportion of the solids than in other breeds; in other words, less skim milk is produced to the pound of fat. The second is the smaller proportion of the ration used for maintenance. A Jersey weighing 900 pounds will produce as much fat on the average as a Holstein weighing 1,250 pounds. In this case the cost of maintaining the larger cow adds to the feed cost of the fat produced.

The most prominent and best known characteristics of Jersey milk are the high per cent of fat, the pronounced yellow color, and the easy creaming of the milk. The latter characteristic is due to the unusually large fat globules. The large fat globules also cause the fat to churn easily, which is something of an advantage in butter-making. The same ease of churning is a slight disadvantage when the milk is to be handled much, as in the market milk business, because it results in small masses of butter appearing on the surface.

In persistency of milking the Jersey ranks very high, probably the highest of any breed. Cows of this breed are general favorites as family cows on account of the richness of their milk, its easy creaming characteristics, their persistency of milking, their easy keeping qualities and gentleness. The Jersey cow finds her special adaptation as a family cow or as an economical producer of butter fat.

Advanced Registry. In 1884 the Jersey Cattle Club authorized seven-day butter tests. The first volume of these tests was published in 1889. These tests covered seven days' time and were made by the owner, who afterwards took oath to the correctness of the results reported. Cows producing 14 pounds or more of butter in seven days were admitted to this registry, and such cows were afterwards spoken of as tested cows, or were said to be in the "14-pound list." These early private butter records, while probably in the main correct, are not looked upon by the public with the same confidence as are those made more recently under official supervision. The highest among the private seven-day records is Princess 2d, who is credited with a production of 46 pounds of butter in seven days from 299 pounds of milk. If this was normal butter containing at least 82.5 per cent of fat, the milk must have contained 13.7 per cent of fat. Since the Babcock test has been in use no cow in this breed has been found to test much over 7 per cent when any quantity of milk is produced.

In 1903 the Register of Merit was established and the rules were changed to admit records made by using the Babcock test.

In 1911 the rules were amended so that only authenticated butter fat and milk records were accepted covering seven days or a full year, and in 1919 the seven-day test was dropped and provision made for a 305-day test.

Cows are entered in the Register of Merit in three classes, the requirements of which are as follows:

Class AAA. A cow shall be entitled to entry in this class provided
(*a*) She meets the requirement of fat production for the 305-day period, and
(*b*) Gives birth to a living calf within a period not exceeding fourteen months from the day of previous calving.

Class AA. A cow shall be entitled to entry in this class provided
(*a*) She meets the requirements of fat production for the 365-day period, and
(*b*) Gives birth to a living calf within a period of sixteen months from the day of previous calving.

Class A. A cow shall be entitled to entry in this class provided
(*a*) She meets the requirement of fat production according to her age for either the 305- or 365-day period.

A two-year-old heifer must produce 290.5 pounds of fat and a mature cow 400 pounds of fat in 365 days; while for the 305-day record the requirement for a two-year-old heifer is 250.5 pounds of fat and for a mature cow 360 pounds of fat. For all ages between two and five years, one-tenth of a pound of fat per day is added for each day said age exceeds two years.

A bull shall be entitled to entry in the Register of Merit that has three daughters out of different dams entered therein.

Official Testing is conducted in the usual manner. The owner weighs the milk from each milking during the test period and for two days in each month the milk is weighed and tested by the representative of an experiment station. The average of the per cent of fat for these two days is taken as the average for the month.

The Register of Merit has been making rapid strides in recent years and nearly 15,000 records have been accepted by the Club. An analysis of the Register of Merit records affords a fair estimate of the relative ability of animals of different ages, and gives some indication of the average butter-fat tests for these classes. However, these figures are not representative of the breed as a whole, as they are taken only from a group of animals selected from the entire cow population to be tested. The figures are of some value, and are given in the table below.

Table 8. Summary of Register of Merit Records

No. of Records	Class	Average		
		Lbs. Milk	Per Cent Fat	Lbs. Fat
4,362	2-year-olds and under . . .	6,631	5.40	358
2,092	3-year-olds	7,668	5.41	415
1,574	4-year-olds	8,524	5.35	456
4,124	5-year-olds and over	9,281	5.28	490

The following are the ten highest yearly butter fat records:

	Lbs. Milk	Lbs. Fat
Darling's Jolly Lassie	16,425	1,141
Goff's Constance	17,942	1,130
Prince's Emma of H. S. F.	18,437	1,109
Lad's Iota	18,632	1,048
Plain Mary	15,256	1,040
Vive La France	15,271	1,039
Sophie's Agnes	16,212	1,000
Sophie 19th, of Hood Farm	17,557	999
Spermfield Owl's Eva	16,457	993
Old Man's Darling 2d	14,631	983

The highest milk record for this breed is 20,616 pounds in 365 days, made by the cow Fauvic's Star.

Prominent Jersey Families. There are some fairly well marked families in this breed. The first to gain prominence was the St. Lambert. This family originated in Canada, and is descended from the cattle imported by Stephen of Montreal and St. Clair of Vermont. The bulls Stoke Pogis and Stoke

Pogis 3d are supposed to be predominant factors in the formation of this family, which included many of the best known animals of this breed in America. Animals of this family, as a rule, are large in size and often rather coarse in makeup, generally fawn or gray in color, and seldom black. It has produced many remarkable dairy cows. Like other prominent Jersey families it is deeply inbred.

Other families which have gained distinction are the Golden Glow, Eminents, Raleighs, St. Mawes, Owl-Interests, Majestys, and Sophie's Tormentors. Each of these families has descended from a great foundation bull whose blood has been concentrated by close line breeding or in-breeding.

CHAPTER VI

GUERNSEYS

Origin and Distribution in Europe. The Guernsey breed originated on the island of the same name. Like the Jerseys, they are presumably descended from the cattle of France, but their true origin has not been distinctly determined. Early accounts indicate that in the year 960 an order of monks settled on the Island of Guernsey and brought with them small native cattle from Brittany. About 1061 another monastery was established, and the monks in this monastery introduced the larger brindle cattle of Normandy. The crossing of these two stocks is believed to have laid the foundation for the present Guernsey breed. A century ago the cattle on the islands of Jersey and Guernsey were practically the same in form and color, but even then the Guernsey is said to have been a little larger. In 1824 laws were passed prohibiting the importation of cattle into Guernsey, and since that time the breed has been kept pure.

Professor Low, writing in 1841, says that the cattle of Guernsey and Jersey were at that time essentially the same, although he further describes the former as being larger, the form rounder, and the bones less prominent than with the cattle on Jersey Island. He also refers to the unusually orange yellow skin and yellow milk and butter. It appears from his writings that these two breeds at that date were nearer together in type than is now the case, but that the Guernseys showed the same characteristics in general as at present. There appears to be fairly substantial evidence of an occasional introduction of Jersey blood several generations back. The present marked difference between the two breeds is doubtless due largely to the developments of the past fifty years.

The Guernseys have been taken to England in considerable numbers, and are used considerably, especially in the southwestern part, but on the whole they are of little importance in that country from a dairy standpoint on account of their comparatively small numbers. They are not found elsewhere in Europe to any extent.

Conditions in Guernsey. The conditions on Guernsey Island are practically the same as in Jersey. The Island is second in size of the Channel group, and has a population of about 45,000. It is ten miles long, with an area of about 16,000 acres—of which 12,000 are tillable. The climate is a little more severe than that of Jersey, as it is exposed toward the northwest. The south coast rises from 200 to 400 feet above the ocean, and slopes to the level of the ocean on the north.

The system of agriculture and the general management of the cattle is much the same as that followed in Jersey. There are about 8,000 cattle on the Island, and they are mostly in small herds of three to six cows. Green feed is available throughout the year. In addition the cattle are fed largely on hay and roots; but the practice of feeding grain in addition is being more generally adopted and is resulting in improved condition of the cattle. The Guernsey breeders have kept in view the idea of utility alone, and have given less attention to the development of the beauty of their breed. In 1830 a scale of points was adopted to establish uniformity in the breed. This has been continued with occasional modifications to the present time.

In 1879 the first Guernsey Herd Book was published which was later accepted by the Royal Guernsey Agricultural Society. In 1881 a rival publication known as the *General Herd Book of the Island of Guernsey* was set up, but apparently the latter was unsatisfactory, and in 1902 the American Guernsey Cattle Club ceased to recognize it.

A system of advanced registry testing quite similar to that

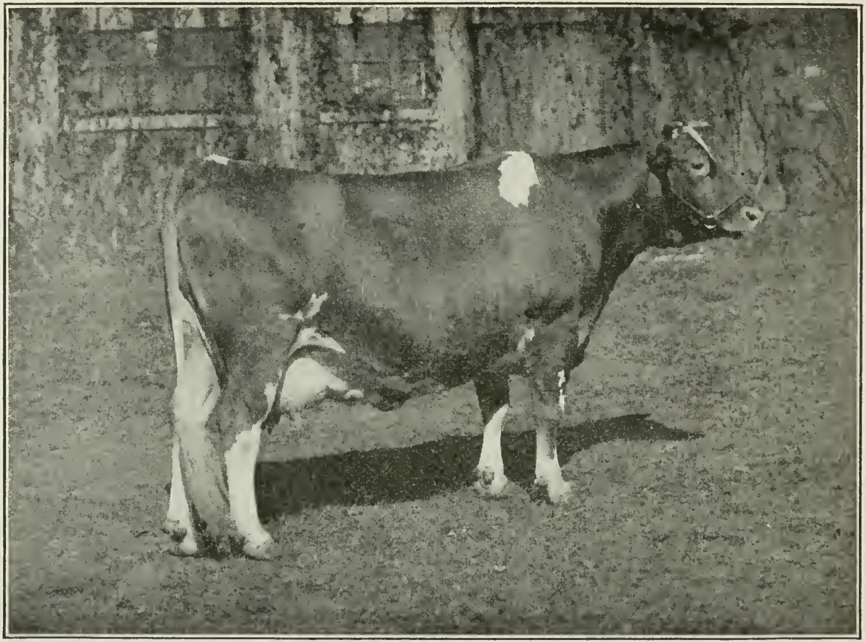


Fig. 17. Guernsey cow, Machere Procris. She combines great producing ability with show ring type. Grand champion National Dairy Show, 1921. Record: milk 17,922 lbs., fat 831 lbs.

of the American Guernsey Cattle Club was adopted in 1911 by the Royal Guernsey Agricultural and Horticultural Society.

Importation to America. According to C. L. Hill[1], the chronicler of the breed, the first Guernsey cattle introduced into this country on which acceptable records were kept were an importation by a Mr. Price, of Boston, Massachusetts, about 1830. Descendants of these cattle have been recorded by the American Guernsey Cattle Club. The same writer records another importation in 1840 by Nicholas Biddle of Pennsylvania. Small numbers were brought in at infrequent intervals, but it was not until about 1880 that they began to arrive in appreciable numbers. About that time S. C. Kent, of Pennsylvania, became one of the most active importers. There was a lull in the movement from 1895 until 1901, when importations were renewed and have continued up to the present time.

The American Guernsey Cattle Club was founded in 1877. Up to the present there have been something like 180,000 animals registered in the Guernsey Register, the first volume of which was issued in 1878. Of these, close to one-third are bulls.

Guernseys are distributed most abundantly in the East, especially in New York, Massachusetts, and Pennsylvania, and in the West in Wisconsin and Minnesota. Their rapid increase in popularity within recent years has been brought about to no small extent by the excellent system of yearly records established by the Guernsey Cattle Club and by the excellent records made.

Form and Characteristics. The Guernsey cow weighs about 1,000 pounds on the average, ranking in size about the same as the Ayrshire, and at least 100 pounds larger than the Jersey. This breed is coarser boned and more irregular in conformation than the Jersey. The colors resemble the Jersey in general, but include some colors not found in that breed. The common colors are a reddish yellow, or lemon or orange fawn, with white

---

[1] *The Guernsey Breed* (1917).

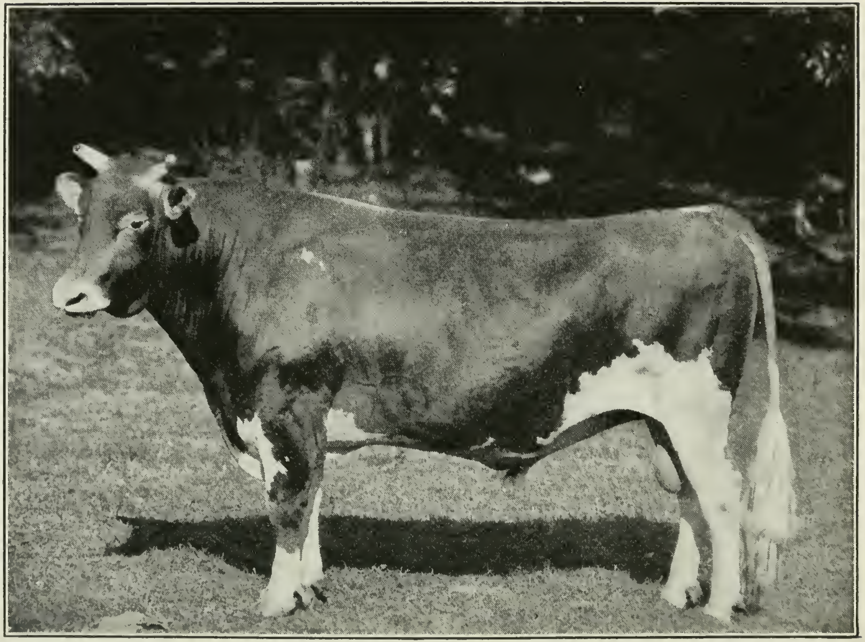


Fig. 18. Guernsey bull, Cherub's Prince. Grand champion National Dairy Show, 1921

markings. The white markings are usually found on the face, flanks, legs, and switch, but may be on any part of the body. A cream colored nose is desired and many breeders are prejudiced against black muzzles.

The temperament of the Guernsey cow is good. She is alert and wide awake, but not nervous and irritable. She has a good dairy conformation, and gives the impression of a plain animal bred for utility. While the breed still lacks uniformity in type to some extent, there has been a marked improvement in this respect in recent years. As a breed they do not mature quite as early as do the Jerseys. The heifers should come into milk at the age of 26 to 28 months. Like the Jersey, this breed has little adaptation for meat production.

Dairy Characteristics. In the yield of milk and fat percentage the Jersey and the Guernsey are not far apart, the Jersey leading slightly in richness of milk and the Guernsey in total milk production. A summary of records from herds owned by Experiment Stations shows an average yearly production for all ages of 5,500 pounds of milk and 274 pounds of fat. These data also show the fat to constitute 35 per cent of the solids as compared with 34.5 per cent for the Jerseys and 28 per cent for the Holsteins.

Under farm conditions a yield of about 5,500 pounds of milk yearly should be expected as an average for all cows in milk, including the usual proportion of heifers. An average yield of 6,000 to 6,500 pounds is possible under exceptionally good farm conditions. The fat content will be five per cent or a trifle less on the average. In color, Guernsey milk ranks first and for this reason it is often mixed with that of other breeds for the sake of the high color it imparts. Guernsey cream, on account of its color, is in demand for table use, and it often commands a premium on the market on this account.

The color of Guernsey butter is so high, especially when the cows are on fresh pasture, that it is occasionally objected to on the market by those not familiar with it. The fat globules are on the average the largest of all breeds. The Guernseys have the same advantages and disadvantages as the Jerseys as producers of market milk. On the whole, it can hardly be claimed that the breed is especially adapted for this purpose since it is seldom possible to sell market milk on such a basis as to do justice to the very high testing product. However, in economy of production of butter fat this breed ranks high on account of the richness of the milk and the large production in proportion to the size of the animal. For this reason the Guernsey breed is most often used where cream is sold either for butter purposes or for table use.

Guernsey Families. The concentration of blood of certain individuals resulting in the formation of well-defined families is not so extensively practiced by Guernsey breeders; but the distinction gained by the descendants of some animals has led to a demand for offspring of similar breeding. Perhaps the most prominent group of this kind is the May Rose family, descended from the cow of that name. Numbered among her descendants are Imp. King of the May, Ne Plus Ultra, and other animals both male and female that have won fame. Imp. Glenwood Girl, through her twelve calves, left a long list of productive descendants. The bulls Governor of the Chene, Sheet Anchor, and Masher may also be listed as founders of families of renown. Governor of the Chene has the distinction of being the first bull of any breed to have one hundred daughters with yearly records.

Advanced Registry Results. No breed has profited more by advanced registry testing. An excellent system of testing for this purpose was adopted by the Guernsey Cattle Club in 1901. The test period at first was for either seven days or a year; but the short-test period was soon discarded and now all tests cover a year. The testing is supervised in the usual manner by the agricultural college or experiment station. The test supervisor weighs and tests the milk of each cow for either one or two days as preferred by the owner.

A cow beginning her record at the age of two years or less must produce 250.5 pounds of fat in 365 days. This requirement is increased one-tenth of a pound for each day over two years of age until it reaches 360 pounds of fat at five years of age, after which no further increase is made. The requirements as given by classes below are in each case for the minimum age in that class, and are increased by one-tenth pound of fat for each day of age above the minimum of the class. Double-letter classes are also used and entry in these classes is a greater distinction than in the single-letter class. To qualify for the double-letter class a cow must in addition to meeting the fat requirement for her age carry a calf for 265 days during the test.

TABLE 9. REQUIREMENTS FOR ENTRY IN ADVANCED REGISTER

AGE—YEARS	CLASSES		LBS. FAT REQUIREMENT
5 or above	A	AA	360 to 400.0
4½ to 5	B	BB	341.8 to 381.7
4 to 4½	C	CC	323.5 to 363.5
3½ to 4	D	DD	305.3 to 345.2
3 to 3½	E	EE	287.0 to 327.0
2½ to 3	F	FF	268.8 to 308.7
2 to 2½	G	GG	250.5 to 290.5

A bull is admitted to advanced registration automatically after two of his daughters have been entered. The appreciation of the value of advanced registry testing is attested by the fact that more than 12,000 records have been accepted by the Guernsey Cattle Club. This is also a tribute to the breadth of vision of the men handling this breed.

Table 10 is a summary of the advanced registry records subdivided according to the age of the animals.

TABLE 10. SUMMARY OF RECORDS OF ADVANCED REGISTRY TESTING

AGE	NO. RECORDS	AVERAGE LBS. MILK	AVERAGE PER CENT FAT	AVERAGE LBS. FAT
5 yrs. and over	3,429	10,377	4.98	516
4½ to 5 yrs.	725	9,879	4.99	493
4 to 4½ yrs.	898	9,547	5.03	480
3½ to 4 yrs.	990	9,204	5.05	465
3 to 3½ yrs.	1,127	8,519	5.05	430
2½ to 3 yrs.	1,366	8,285	5.06	419
Under 2½ yrs.	2,902	7,985	5.00	399

The following are the highest records for the Guernsey breed up to the present:

NAME	LBS. MILK	LBS. FAT
Countess Prue	18,626	1,103
Murne Cowan	24,008	1,098
May Rilma	19,673	1,073
Nella Jay 4th	20,709	1,019
Langwater Nancy	18,783	1,011
Langwater Hope	19,882	1,003
Yeksa's Tops of Gold's Fannie . . .	19,794	981
My Fancy of Falcon's Flight . . .	18,214	979
Spotswood Daisy Pearl	18,602	957
Julie of the Chene	17,661	953

CHAPTER VII

AYRSHIRES

Origin and Distribution in Europe. The native home of this breed is the county or shire of Ayr in southwest Scotland. It is comparatively a new breed, but has made wonderful advancement in a short time. The origin of this breed is veiled in some obscurity, but traces back to the latter part of the eighteenth century. The cattle of this district were described in 1750 as being small, ill-fed, ill-shaped, and producing but little milk. In color they were black and white. This foundation stock was probably descended from or kin to the original wild white cattle described in early historic records and represented now by the wild park cattle.

During the latter half of the eighteenth century a widespread movement for better cattle spread over Great Britain, and resulted in an immense improvement being made in the cattle of Ayrshire as elsewhere. The improvement was brought about by more careful selection and breeding, and especially by the introduction of blood from several other regions. According to Howard,[1] writing in 1863, cattle imported from Holland furnished one of the most important crosses made. Another important cross was made with cattle of the Durham or Teeswater breed, which afterwards in the improved form became known as the Shorthorns. It is reasonably certain, according to Howard, that Channel Island blood was also introduced quite generously. It is also probable that Holderness blood was introduced to some extent at an early date.

Professor Low, the eminent English authority, makes the following statement: "From all evidence which, in the absence of authentic documents, the case admits of, the dairy breed of Ayrshire cows owes its character to a mixture of the blood of the races of the Continent and of the dairy breed of Alderney."

---

[1] Herd Record of the Association of Breeders of Thoroughbred Neat Cattle, Vol. I.

In Ayrshire some attention has always been given to the beef-making capacity of the breed, especially in the early period of their development. During the early part of the nineteenth century, the hind quarters especially were improved and the udder brought to its present symmetrical proportions.

The Ayrshires are the leading dairy cattle in Scotland, and are common in some parts of England. They are one of the few British breeds that has spread to any extent on the Continent of Europe. They are quite numerous in Finland, Sweden, and Norway, while in New Zealand they are one of the important dairy breeds.

Conditions in Ayrshire. Ayrshire is situated on the southwest coast of Scotland. The land rises from the level of the ocean on the west to mountains about 2,000 feet high on the east. The soil is a heavy clay of moderate fertility spread over a hilly surface. The temperature ranges from 25 to 65° F. during the year and is not subject to great extremes, although occasionally swept by fierce storms. The moist air and abundant rainfall result in good pastures. The milk is used mostly for cheese making.

Importation and Distribution in America. Ayrshires were brought to Canada by Scotch settlers in the early part of the nineteenth century. More recently the importation of breeding stock into Canada has been extensive. The first importation into the United States was probably in 1837, when several were brought to Massachusetts by the Society for the Promotion of Agriculture, although it is claimed that some were taken to Connecticut as early as 1822. These importations continued at intervals for twenty to thirty years, then gradually ceased, largely on account of the serious objection raised to the short teats of the imported animals.

Descendants of these importations were bred and developed in the Eastern States and when importations from Scotland again became numerous within the last twenty years, it was found that the New England Ayrshires were considerably different animals from the breed as it has been developed in Scotland. The type as developed in the Eastern States came to be known as the American type in contrast to the imported animals known as the Scotch type.

In recent years the importations of Ayrshires both to Canada and the United States have been numerous, and the imported type has practically superseded the type formerly common.

The Ayrshire breed has never been boomed and, until recently, has not even been well advertised in the United States. Their increase in popularity has been due, therefore, entirely to their merits. The first herd book of the breed was established in the United States in 1863 and the publication of the Scotch Herdbook began in 1878, and of the Canadian in 1870.

A total of 29,998 pure-bred Ayrshires are reported by the census of 1920. The leading States in order of numbers are New York, Vermont, Pennsylvania, Massachusetts, and Wisconsin. The breed is also common in sections of eastern Canada, where in some localities it is the predominating breed.

Breed Characteristics. In size the Ayrshires rank between the Jersey and Holstein breeds. The average cow weighs about 1,000 pounds at maturity, while some exceed this figure considerably. The bulls range from 1,400 to 2,000 pounds. The tendency in America has been to favor a rather larger type than that considered most desirable in Scotland.

The common color is spotted red or brown and white, in varying proportions. In the old American type the red or brownish-red usually predominated, with only a small amount of white; while in the modern or Scotch type, the white gener-

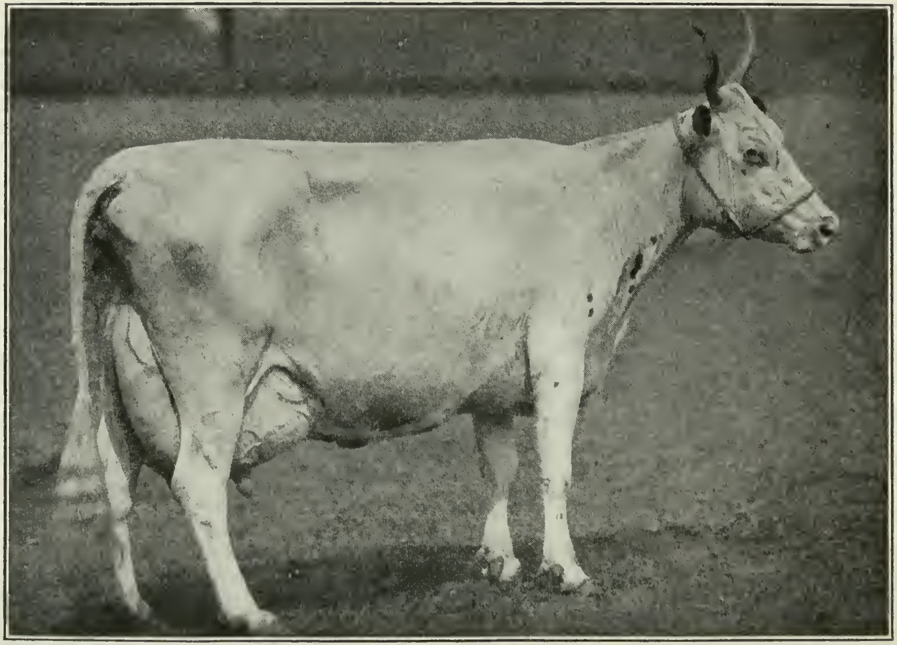


FIG. 19. Ayrshire cow, Garclaugh May Mischief. Present holder of the milk record for the breed: Milk 25,325 pounds, fat 895 pounds

ally predominates. The two colors are distinct, and do not blend to form a roan. The horns are rather long, and as a rule curve outwards and upwards and in some cases slightly backwards. The bulls have very heavy horns.

In disposition they stand rather between the Jersey and Holstein. They are more active and alert than the Holstein and, like them, are less affected by unusual surroundings than are some other breeds. In form the Ayrshire do not show the extreme angular dairy type exhibited by high-class Jerseys or Holsteins. They are smoother over the shoulders, back, and hips, and have fuller rear quarters. At the same time, the barrel is large, showing great capacity, and the udder development the most perfect of any breed. For many years the Scotch breeders have bred especially for large, symmetrical udders, and have attained this end with remarkable success. The udder is attached high behind, and extends far forward, with a flat, even, lower surface. The teats are placed regularly on the udder, and are of uniform size. Ayrshires are regular and sure breeders, the probable result of the favorable conditions under which the breed has been developed, and of the avoidance of inbreeding.

The chief criticism of the imported Ayrshires and their descendants is the short teats, which are often altogether too small for convenience in milking. This objection, which seems to be given more weight in America than in their native home, is receiving the attention of American breeders and will soon be a thing of the past.

Cows of this breed also show a tendency in many cases to lack persistency in milking. This is especially noticeable with the short-bodied, blocky type of cows which are quite common in herds of Scotch breeding.

The Ayrshire is not so early a maturing breed as the Jersey, ranking about with the Holstein in this respect. At 24 months of age the Ayrshire cow, on the average, has attained 94 per cent of her mature height, while the Jersey has reached 97 per

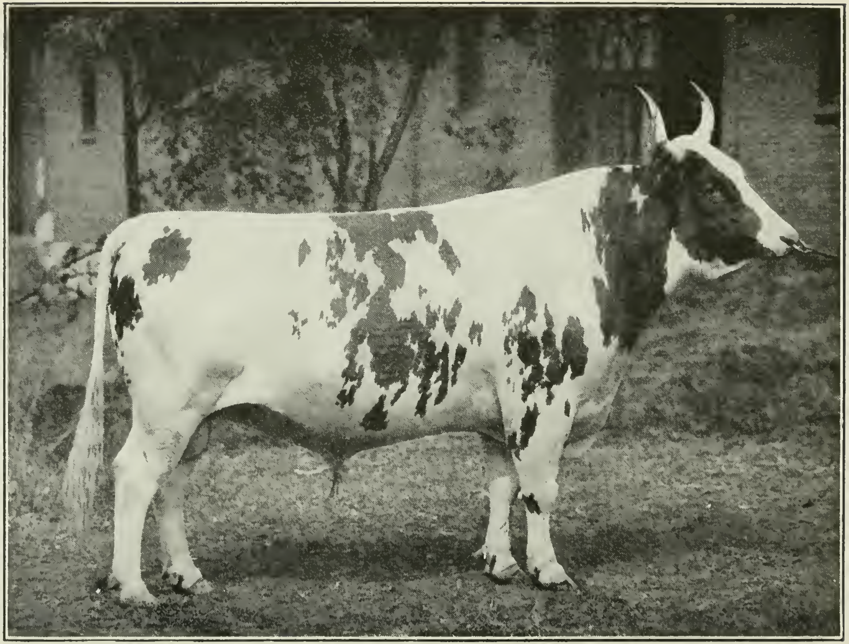


Fig. 20. Ayrshire bull, Howie's King of Hearts. Grand champion National Dairy Show, 1922

cent at this age. The Ayrshire reaches full weight at the age of approximately 6 years. Cows of this breed are sufficiently mature to come into milk between 26 and 30 months of age. It is claimed this breed retain their breeding powers and remain profitable producers to a greater age than is common with other breeds.

One of the strong points of the breed is their excellent grazing qualities. They will thrive and keep in excellent condition on pastures where animals of the larger breeds, especially the Holstein, will find it difficult to maintain themselves. The author has observed this in a striking manner when pasturing a group consisting of pure-bred Holsteins, Jerseys, Shorthorns, and Ayrshire heifers in the same pasture during a season of poor pasturage. The Ayrshire made excellent gains and kept in good flesh, while it was necessary to feed considerable grain to the Holsteins to keep them in even a fair condition of flesh. The others were given no grain, and remained in fair condition—but uniformly below the Ayrshires.

Calves of the Ayrshire breed weigh 60 to 75 pounds at birth and are usually strong and vigorous although not equal to the Holsteins in this respect. The breed ranks high in beef production for a dairy breed. When dry, the cows fatten readily and are said to furnish a good grade of beef.

Dairy Characteristics. As a breed, the Ayrshires are noted for a good, uniform production of milk. While some very large milk and fat records have been made in official tests, Ayrshires have not so far equalled the Holsteins, Guernseys, and Jerseys in this respect.

A compilation of records published by experiment stations shows an average yearly milk yield of 6,530 pounds with a fat content of 3.85 per cent. Under good farm conditions with reasonable attention to culling out the inferior animals an average yearly milk production for a herd should be from 6,500 to 7,000 pounds with a fat content of a little less than four per cent, making an average fat production of from 250 to 280 pounds of fat, including cows of all ages. A production lower than this calls for a careful consideration as to the methods of selection and feeding practiced. A figure much above these indicates an excellent herd well managed.

The fat globules are small and the milk and butter do not show much yellow color, ranking in this characteristic with the Holsteins. The Ayrshire cow is well adapted for the production of market milk on account of the large yield of milk of average composition. The lack of a more pronounced yellow color is some disadvantage in this connection, while the small fat globules resulting in less trouble from churning in transit is something of an advantage.

The milk of this breed is also well adapted for cheese making on account of the small fat globules and relatively high per cent of casein, and is generally used for this purpose in their native land.

In economy of fat production the Jersey and the Guernsey breed slightly excel the Ayrshire for reasons explained elsewhere. In regard to milk production the reverse is generally true.

Advanced Registration. A system of Advanced Registration based upon official tests was established by the Ayrshire Association in 1902.

The requirements to the Advanced Register differ from those of other breeds in having a minimum milk standard in addition to the fat requirement. The period of test in all cases is 1 year. Beginning with 250.5 pounds of fat at two years of age the requirement increases one-tenth of a pound for each day of age beyond 2 years. The requirements for different ages are as follows:

Age	Class	Lbs. Milk	Lbs. Fat
2 to 2½ years	G	6,000	250.5
2½ to 3 years	F	6,500	268.8
3 to 3½ years	E	7,000	287.0
3½ to 4 years	D	7,500	305.3
4 to 4½ years	C	8,000	323.5
4½ to 5 years	B	8,500	341.8
Mature, 5 years and over	A	9,000	360.0

In addition, a Roll of Honor list is maintained in which are entered cows meeting the requirement of Advanced Registration in her class within 300 days and giving birth to a living calf within 100 days after the close of her test period.

Bulls are admitted when four daughters from different dams have qualified.

Up to 1923 a total of 4,695 cows of all ages have been admitted to Advanced Registration with an average production of 9,965 pounds of milk, and 396 pounds of fat, the fat percentage averaging 3.97.

The highest record cows are as follows:

	Lbs. Milk	Lbs. Fat
Garclaugh May Mischief	25,329	894.9
Auchenbrain Brown Kate 4th	23,022	917.6
Lilly of Willowmoor	22,596	955.6
Auchenbrain Yellow Kate 3d	21,123	888.0
Jean Armour 3d	21,938	859.7

About ten others have produced above 800 pounds of fat in a year.

CHAPTER VIII

BROWN SWISS

Origin. There are two distinct and leading breeds of cattle in Switzerland, and several minor ones closely related to them. In the western portion, including the region around Berne, the Simmenthaler is the common breed. This is a large-boned, spotted red-and-white breed used for milk and beef as well as for work. They have not been imported into this country. The other Swiss breed, known in Switzerland as the Braunvieh or Schwyz and in America as the Brown Swiss, is found in the northeast part in the cantons of Zurich, St. Galen, Luzern, and Schwyz.

This breed is probably one of the oldest in existence and is supposed to be descended from the cattle which have been used in this locality since before historic records began. According to Kellar, this breed represents the *Bos sondaicus,* the smaller of the two types of wild cattle supposed to have been domesticated. Bones found in the ruins of the Swiss Lake Dwellers, which date back to the Bronze Age, show a type of cattle which are apparently closely related to the present Swiss cattle. It is not believed that any considerable infusion of foreign blood has ever been introduced. The Brown Swiss is one of the few breeds originated on the Continent of Europe that is used outside of its native locality. This breed has spread over about one-half of Switzerland and largely into the noted dairy districts of Algau in Bavaria. The foreign demand for the breed shows its merits. Buyers from Germany, Hungary, and other parts of Europe take the surplus cows at figures considerably above the current market prices for dairy cows in their home localities.

Conditions in Switzerland. The total area of Switzerland amounts to 15,976 square miles, of which about 71 per cent is said to be productive. The total number of dairy cows is approximately three quarters of a million. From these are produced milk and dairy products sufficient for a population of three and a half million and to manufacture around 70,000,000 pounds of cheese and a considerable quantity of condensed milk for export use.

The Brown Swiss cattle are found from the shores of Lake Constantine, at an elevation of 1,400 feet above the sea, to near the line of perpetual snow in the Alps. During the winter season the cattle are kept in the valleys and stabled closely in rather warm but dark, poorly ventilated barns—and in not especially sanitary conditions. During this season they are fed almost entirely upon hay grown in the meadows in the valleys, which is handled with the greatest care and is of exceptional quality. In addition they are fed turnips, potatoes, and a small quantity of grain, usually oil cake, but never more than three or four pounds per day. As spring opens they are taken to the edge of the valleys and lower Alps, up to an elevation of about 3,000 feet, where they are pastured on an average of about 116 days.[1] As the summer advances, the herds are moved upwards to the Middle Alps, which are at an elevation of from 3,000 to 6,500 feet, where they are pastured on an average of 92 days. In July and August they are taken on to higher pastures, which are called the High Alps, at an elevation of from 6,000 to 8,500 feet. As winter approaches the cattle are taken to the lower levels. During the summer season they are out of doors practically all the time, being sheltered at night during the cold weather and in case of storms in the temporary shelter sheds which are built on the mountains. The herds are accompanied by the herders who remain with them and who take the milk to the cheese makers. During the summer the milk is used almost exclusively for cheese making, but during the winter it is used in part for butter making. The calves are usually born in the spring in the herds that pasture in the mountains; but in the herds that remain in the valleys, the cows often freshen in the fall.

---

[1] Bacchler Massuger, *Journal British Dairy Farmers' Association*, Vol. X, p. 47.

Importation and Distribution in America. The first cattle of this breed to be imported to the United States were brought by H. M. Clark of Belmont, Massachusetts, in 1869. In 1882 an importation was made by Scott and Harris of Massachusetts. In all, less than 200 head have been imported. This limited number as compared with other breeds is largely accounted for by the prevalence of foot and mouth disease on the Continent of Europe—as a result of which the importation of cattle from continental Europe during the past forty years has been possible only for short periods, when the quarantine was relaxed.

Up to 1921 approximately 25,000 have been recorded. The census of 1920 enumerated 8,360 head of pure-bred animals of this breed. They are found at the present time in almost every state, but nowhere in large numbers. Wisconsin, Illinois, and New York rank in the order given at present in the development and use of this breed. The increase in numbers and popularity of this breed has been based entirely upon its merits. But little advertising has been done by either the breed association or by the breeders.

Breed Characteristics. In appearance, animals of this breed are plain, substantial, and well proportioned—although rather fleshy—and give the impression of being somewhat coarse in the bone and in general make-up. The head and neck especially are large, as contrasted with the English breeds of cattle, and seem rather plain and coarse. The back is well developed and the hair abundant and soft. As a rule the skin is of unusually fine quality. The hind quarters are full, round, and inclined to be distinctly beefy. The cows have large, well-shaped udders with teats of sufficient size to be milked conveniently. Milk veins and milk wells are of medium development. In size, the cows reach an average weight of about 1,200 pounds and the bulls from 1,600 to 2,000 pounds. The color varies considerably in shade. It is called brown, but more of a mouse color is prevalent. The brown varies from a silvery gray or light brown to a dark brown or almost black. The nose, switch, tongue, and horn tips are always black. The mouth is surrounded by a mealy ring, and a light stripe is usually found along the backbone. Small patches of white on the under line near the udder are not objectionable, but white on other parts of the body is not desirable, and in Switzerland it disqualifies the animal. The uniformity in color markings adds to the attractiveness. The head, neck, and legs may be almost black.

In disposition this breed is especially good, being quiet and docile and easily handled. No distinct types of breed are recognized as is the case with some other breeds, but there is considerable variation in types, depending upon where they were raised, and for what purpose. Those cattle raised in the higher altitudes are said to be somewhat smaller than those raised in the valleys. Some herds have been kept largely for the purpose of raising work animals, which has resulted in the herds' being of a larger and coarser type.

The Brown Swiss breed is not a very early maturing one—ranking about with the Holstein breed, or perhaps a little behind in this respect. In Switzerland the cows usually come into milk at about three years of age. While they are rather slow to mature, they are noted for continuing to be sure breeders until they reach an advanced age. Their excellent breeding characteristics, which are one of the strong features of this breed, come from the favorable conditions and the sensible management under which they have been kept.

In its native home this breed is considered a dual-purpose breed, and it was formerly so classed in the United States. However, the Brown Swiss breeders in America have decided that their stock shall be classed as a dairy breed, and they have indicated their intention to develop it with this purpose in

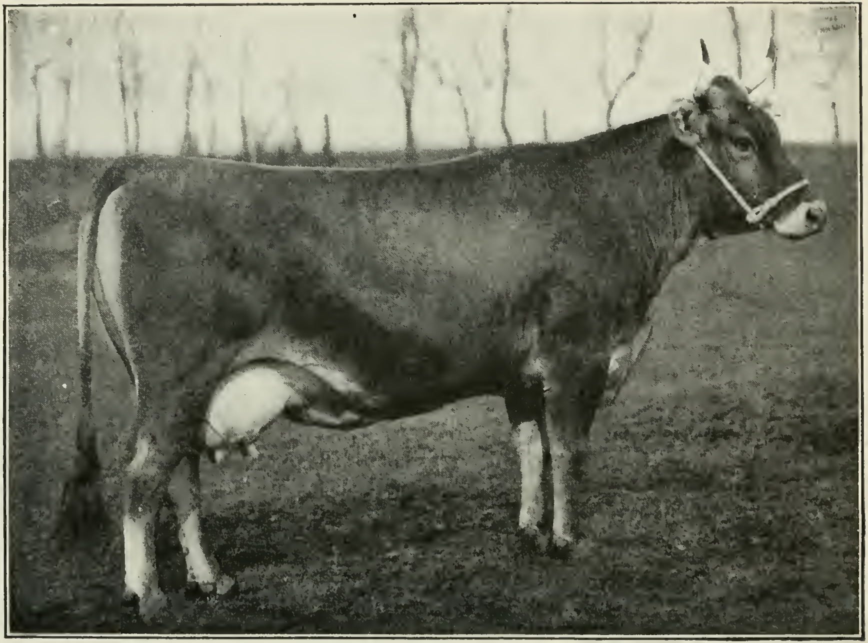


FIG. 21. Brown Swiss cow, Hawthorne Dairy Maid. A typical representative of the breed and present holder of the butterfat record for the breed. Record: milk 22,622. fat 927 pounds.

view. The animals produce a fair quality of beef, grow rapidly, and reach a good size at an early age; but they are not received very well on the market on account of the large bones, and probably, in part, from prejudice on account of their similarity in color to the Jerseys. For production of veal they rank high, as the calves are large at birth and grow rapidly.

Dairy Characteristics. The records of the milk and butter fat production available for this breed are not extensive, but they indicate a very satisfactory average yield. The United States Consul at Zurich reported some years ago that 6,000 cows supplying the Anglo-Swiss Condensed Milk Company averaged 5,115 pounds of milk yearly with an average fat content of 3.68 per cent. A herd of fifty cows owned by the Agricultural School at Plantahof for five years averaged 5,990 pounds of milk for each cow in milk. The highest fat yield was 513 pounds, while 23 were above 400 pounds. It should be kept in mind that these figures represent the production of cows receiving little if any grain in accordance with the common feeding practice of Europe. One of the leading herds in the United States at one time included 33 animals with an average record of 9,000 pounds of milk in a year. Nine of these had exceeded 11,000 pounds. Under good farm conditions with reasonable care in culling the inferior animals, a herd of Brown Swiss should be expected to average from 6,000 to 7,000 pounds of milk yearly with a fat content of about 4 per cent. The average percentage of dry matter is 12.5. In composition the milk of this breed is well adapted for market milk purposes, containing about the proper amount of fat and solids. In natural color the milk is about the same as that of the Shorthorn breed.

Advanced Registration. In Switzerland the interests of the breed are looked after very carefully by a cooperative association which is subsidized by the government. The animals used for breeding purposes are approved by representatives of this association which also holds fairs at intervals which serve as means for marketing surplus animals. The breeding herds are well controlled by this association and their interests promoted so skillfully that the surplus stock is readily disposed of at good prices to meet the demand of other parts of Europe. Authenticated records of milk production are kept of the best cows and the bulls from these cows offered for sale for breeding purposes.

“A system of advanced registry known as the Register of Production was established by the Brown Swiss Breeders Association of the United States in 1911. The requirements for admission differ from most of the other breeds in placing the minimum age at 30 months instead of 24. The age of maturity is also placed at 4½ years in contrast to 5 for other breeds. Two types of tests are provided for; the year's test covering 365 days, with no calving requirements, and the 10 months or 305 days test, which requires a calf born within 14 months from the freshening preceding the test period. The tests are supervised in the usual manner by the agricultural college or experiment station and cover two days each month. The requirements for admission to the Register of Production are now based upon butterfat production alone, the milk production requirements formerly in use having been abandoned. The fat requirements for the cow calving at the age of 30 months are, for the 365 days record 250.5 and for the 10 months class 220.5 pounds. In each class one-tenth of a pound is added for each day of age beyond 30 months. This plan gives a requirement at the even years as follows:

Age	365 days Fat, Lbs.	365 days Fat, Lbs.
30 months	250.5	220.5
3 years	268.7	238.7
4 years	305.3	274.2
5 years	341.7	311.7
5 years, 6 months	360	330

The highest record up to 1923 is held by Hawthorne Dairy

Maid with a production of 22,622 pounds of milk and 927 pounds of fat in a year.

Table 11 gives a summary of the Register of Production:

Table 11. Summary of Official Records for the Brown Swiss

Class	Number of Animals	Average Lbs. Milk	Average Lbs. Fat	Average Per Cent Fat
Mature	100	12,313	485	3.93
5-year-old	44	12,693	502	3.95
4-year-old	31	11,091	445	4.00
3-year-old	54	9,917	403	4.06
2-year-old	55	9,078	364	4.00
Average of all . .	284	11,156	444	3.97

CHAPTER IX

MINOR BREEDS

Dutch-Belted

This oddly colored breed originated in North Holland and has been bred for over 200 years to produce a perfect belt of pure white in the center of a coal black body. Very little is known of its history; it is probably descended from the cattle of Holland, the ancestors of the breed known in America as Holstein.

The Dutch-Belted breed first attracted attention about 1750; but the selection and breeding for the white belt probably began long before this, possibly as far back as the sixteenth century. According to the early records, these cattle were bred by the nobility of North Holland on account of their peculiar markings. Hogs and poultry were also bred with a somewhat similar white body line. The development of these animals with this distinct belt of white between coal black ends of the body is a striking illustration of the possibilities of breeding and selection.

In size, the Dutch-Belted cattle rank about equally with the Ayrshires. Their general form and conformation is more like that of the Holstein, however. The cows weigh from 900 to 1,300 pounds; the bulls from 1,600 to 2,000 pounds. The dairy type is highly developed, being of a highly nervous temperament and a very quiet disposition. Their most distinctive characteristic is the presence of the white belt around the center of the body. This belt should extend around the body from just behind the shoulders to just in front of the hips. Otherwise, the body is coal black.

Importation and Distribution in America. The first importation of Dutch-Belted cattle into America of which we have any record was made in 1838. A second importation was made in 1848. The animals from these two importations were scattered throughout Orange County, New York, where their descendants are to be found at the present time. A large herd was also imported and placed on an estate at Cornwall, Pennsylvania. The cattle of this breed in America today are nearly all descendants of these two herds. In 1840 P. T. Barnum imported a number of Dutch-Belted cattle for show purposes, but he soon sent the cattle to his farm in Orange County, New York. In 1906 one heifer was imported, but prior to this date none were imported for a period of over 50 years, chiefly on account of the scarcity of the animals in their native land. Within recent years, animals of the breed have been exported into Canada, Cuba, and Mexico, Brazil and the Argentine.

In the United States, Dutch-Belted cattle are most numerous in the Eastern States, especially New York, New Jersey, Pennsylvania, Ohio, and the New England States; a few are found in the South, and several small herds are to be found on the Pacific Coast. There are about 6,000 head in the United States at the present time.

Dairy Characteristics. The cattle of this breed are fair milkers. A few cows hold records of over 400 pounds of butter per year. At the Pan-American Exposition at Buffalo in 1901, five Dutch-Belted cows were entered in the cow test in competition with the same number of cows of nine other breeds, and while the five cows of this breed came out last in the test, they made a very creditable showing. The average production per cow for this breed was 4,978 pounds of milk and 169.4 pounds of butter fat during the six months' trial. The average per cent of fat was 3.4. One breeder in New York, after keeping yearly records for eight years, reports that twenty-five cows and heifers averaged 9,000 pounds of milk for one year. A New Hampshire breeder reports eleven cows in his herd which made an average of 8,579 pounds of milk in one year. One cow in this herd produced 12,672 pounds of milk in one year and 60,297 pounds in a period of six years, with an average butter production during the same length of time of 596 pounds.

Registration and Advanced Registry. The Dutch-Belted Association which was organized in America in 1886 has registered between 3,000 and 4,000 animals. In Holland the cattle of this breed are registered in the Netherland General *Staurbuck*, published at The Hague.

A system of making and recording official tests was adopted in 1912. The rules are much the same as those formulated for other breeds. Up to the present time the number of official records made is small.

FRENCH-CANADIAN

The French-Canadian breed is descended from the native cattle of the provinces of Normandy and Brittany, France, and on this account is very closely related to the Guernsey and Jersey breeds.

The French settlers who came from these French provinces and settled in Quebec, Canada, brought their cattle with them and have bred and improved them under the existing conditions and environment for more than 250 years. The cattle have become adapted to severe climates and are noted for their vigor and ability to withstand the cold winters of the North.

In size and conformation they are very much like the Jerseys and Guernseys, the cows averaging about 700 to 900 pounds at maturity. They are active and well adapted to hilly and rough pastures. In color, they are black, or black with a fawn or orange-colored stripe down the back and around the muzzle. In quantity of milk they compare with the Jersey, and the fat content averages between 4 and 5 per cent.

The French-Canadian Herd Book was established in Canada in 1886. Cattle of this breed are found mostly in the Province of Quebec, but also in small numbers in other parts of Canada and in limited numbers in New York and the New England States.

KERRY CATTLE

The Kerry, the smallest of all dairy breeds except the Dexter, originated in southern Ireland, where it has been bred for centuries. Very little is known of the history of this breed prior to the middle of the eighteenth century.

The breed has been developed by the small farmers in Kerry County—tenants, in the main. The Kerry is of a distinctly dairy type. The color is a solid black, although a small amount of white appears on the underline of some cows. The upstanding horns are rather long and slender, with black tips.

The Kerry cow weighs not over 900 pounds, and the bull about 1,000 pounds. As a breed they are slow to mature, but they are vigorous and well adapted to severe weather conditions and are usually good grazers on scanty pastures.

Kerry cows in Ireland are said to produce from 5,000 to 6,000 pounds of milk yearly, while records of 10,000 pounds have been made. In tests supervised by government authorities in Ireland several records of between 7,000 and 8,000 pounds of milk in a year have been made. The fat content averaged about 4 per cent. Few animals of this breed have been brought to America and bred here, and these not primarily for commercial milk production.

DEXTER CATTLE

Dexter cattle are native to the same locality in Ireland as the Kerry, from which they are an offshoot, and are so closely related to the Kerry cattle that only in recent years have the two been kept distinct.

The characteristics of the Dexter are similar to those of the Kerry except that the type is more like that of the dual-purpose animal. The legs are very short, the body well rounded, and the head plain, with horns similar to the Kerry. The color is solid black.

In size the Dexters are about a hundred pounds below the Kerrys, the cows averaging 600 to 700 pounds. Under government supervision cows of this breed in Ireland have produced up to 8,000 pounds of milk in a year with a fat content of about 4 per cent.

DEVONS

The Devons are commonly classed as dual-purpose cattle. They are one of the oldest breeds that originated in Great Britain. Very little is known of their early history, but it is generally believed that they are related to the Hereford and Sussex breeds. Some writers believe that the latter breeds descended from the Devons. The Devons were bred and developed in Devonshire, England, and they are divided into the North and South Devons. The North Devons represent more nearly the original and true type of the breed. The Quartly family of North Devon was largely responsible for the development and improvement made with the Devons. While the breed are classed as dual-purpose animals today, they were bred originally for milk, beef, and draft purposes in their native country. The cows average about 1,000 pounds in live weight, and are hardy, strong, and active. In color they are deep red. White markings may appear on the belly and on the udder. The horns are long, and turn upwards and backwards.

The Devons were first introduced into America in 1817 and a number of importations were made at later dates. They were at one time popular in the Eastern States, where classes for them are still maintained at certain livestock exhibitions. In recent years other breeds have come into public favor more strongly, and the Devon breed has lost ground.

The dairy characteristics of the breed have never been very highly developed; like other dual-purpose animals, they give a large quantity of milk at the beginning of their lactation period, but are not persistent milkers. In a report made by the New York Experiment Station the average butter fat test for 72 head of cattle was 4.15 per cent. Yields of 5,000 pounds of milk per year have been reported. No official milk and butter records have been reported.

The interests of the Devon breed are looked after in America by the American Devon Herd Book Association. The first volume of the Herd Book was published in 1861.

CHAPTER X

DUAL-PURPOSE CATTLE

General Discussion

Definition of the Term. The term "dual-purpose" is used to describe those breeds of cattle which are bred for both milk and beef production in contrast with those called special-purpose, which are bred primarily for either milk or beef. However, the question of beef production in connection with that of milk is largely one of degree since practically all dairy cattle are used for beef when their period of usefulness as milk producers is at an end.

Much of the discussion regarding the question of dual-purpose as compared with special-purpose cattle comes from erroneous ideas of what constitutes a dual-purpose animal. The man who is interested primarily in milk production is inclined to call every cow that does not produce milk profitably —especially if she shows a tendency toward beefiness—a dual-purpose cow. The cow in question might more often be correctly classed as a no-purpose cow. Other dairymen go to the other extreme, and call such cows as the Holstein dual-purpose because they have some value for beef production.

The breeder of pure-bred Shorthorns often calls any cow showing a good-sized udder when fresh a dual-purpose cow. He is inclined to minimize the dairy part of the dual-purpose, as a rule, but at the same time points to large records which have been made by animals of the breed as proof that the breed has dairy qualities.

The true dual-purpose type stands about midway between the extremes of the dairy type, or large milk producers, and the beef type, with little tendency toward milk production. A dual-purpose cow is one that produces a medium quantity of milk for a dairy cow, and that will sell at a fair price for a beef animal when fattened. A dual-purpose breed is one in which these characteristics are so fixed that they are transmitted with reasonable certainty. There is occasionally a dual-purpose Angus or Hereford cow; but these breeds cannot be so classed, for the reason that they do not transmit this characteristic. Again, we find cows in the dual-purpose breeds that are such remarkable milkers and that show such inferior beef-making characteristics that they should be classed individually as special dairy animals, and not as dual-purpose. There is such a thing as a dual-purpose cow, if we correctly define the limitations of the term. It must not be expected that a cow of this type will compare as a dairy animal with good individuals of the special dairy breeds, or that her calves will be able to compete in beef production with those of the special beef breeds. A dual-purpose cow should be expected to produce about 200 pounds of butter fat per year against about 300 pounds for an equally good specimen of the dairy breed; and her calves should make fair beef animals.

Adaptation of the Dual-Purpose Cow. The question of whether the farmer should breed special-purpose dairy cattle or dual-purpose when dairy products are sold from the farm is one that has called forth endless discussion. The view represented by one extreme is that if a cow is to be milked at all, she must be of a special dairy breed, and that no such thing can exist as a profitable milk and beef producer combined. The other extreme holds to the view that the average farmer, who produces the largest bulk of the dairy products of the country, can make the best use of a cow that will produce a fair amount of milk and at the same time raise a calf which will be salable for beef purposes.

The question can best be considered by eliminating the points upon which there is practically no difference of opinion and by concentrating attention upon the points where there is a chance for difference of opinion.

(1) It is generally admitted by all that cows of the special dairy breeds will, on the average, produce more milk and butter, and produce it cheaper, than those of dual-purpose type; and that the special beef breeds excel the dual-purpose in beef production.

(2) The man who intends to make dairying his chief business, with everything else of secondary order, should make use of the special dairy cow, and the man who produces beef animals and does not milk the cows should make use of the special beef breeds.

(3) The highest development of both milk and beef production cannot be combined in the same animal.

This leaves the general farmer for whom the dual-purpose cow is adapted, if for anybody. This large class of farmers, especially in the Central States, sell a number of things from the farm, among which milk or cream occupies a more or less important position.

The main question regarding the dual-purpose cow is whether this type is better adapted than the special dairy breed for such a farmer. If this general farmer, who is using dual-purpose cattle, is asked why he does not use special-purpose dairy cattle in preference to the dual-purpose, he will give one or all of the following reasons:

(1) The calves from the dairy breeds are not salable for beef purposes.

(2) The cows of the dairy breeds are not salable for beef when they are no longer useful for milk production.

(3) The cows of the dairy breeds are delicate and require better care and attention than he can give them.

There is some ground for these statements. The calves of the dairy breeds, as a rule, cannot be raised for beef with profit, and it is often unprofitable even to raise the males for veal.

It is also true that cows of the dairy breeds bring a low figure in relation to the current market price when sold for beef, and when herds are properly weeded out it is necessary to dispose of a considerable number of cows every year. On the other hand, profitable dairy cows, once secured, are usually kept at a profit for a comparatively long time, and the difference in return for the milk produced by a cow of the dairy breed and of the dual-purpose breed far more than makes up for the difference in beef value when placed upon the market. It is also true that cows of the dairy breed need good attention, or they will not be kept at a profit, but it cannot be said that they are especially delicate, although they will be of little value if allowed to go without proper shelter and food. The dual-purpose cow that produces milk for a few months during the summer only is as well adapted as the highly developed dairy cow for the farmer who will not provide the proper conditions. It requires good, intelligent care to make use of so highly developed an animal as the modern dairy cow; the farmers who are not able to meet these requirements might as well let her alone.

There is more to recommend the dual-purpose cow in the corn belt than elsewhere, and here the type is the most numerous. The typical farmer of this region finds it impracticable to secure sufficient labor to carry on a herd of dairy cows large enough to utilize the feed—especially the roughage—grown on the farm. The raising of a number of beef cattle allows surplus roughage, which cannot be put upon the market with advantage, to be utilized with small additional labor.

The dual-purpose cow also serves a useful purpose in many cases as an intermediate step in changing from a system of beef production to milk production when conditions make such change necessary. That is, when the farmer who has been engaged in beef production begins to sell dairy products, he usually milks the cows he has for a time, then gradually changes toward a dairy type by using dairy-bred sires. In this way he gains experience in handling dairy cattle gradually as the herd is developed.

Fully as many difficulties are experienced in breeding dual-purpose cattle as in breeding special-purpose dairy cattle. One of the tendencies observed is for individual breeders to emphasize either the beef or the milk production side, instead of keeping the two of about equal importance. This practice results in dual-purpose breeds varying much in type as bred by different breeders. The judging of dual-purpose cattle in the show ring is often unsatisfactory on account of the lack of a definite standard for such types, and the tendency of many judges is to minimize either the beef or milk-producing characteristics.

THE SHORTHORN BREED

Origin and Development. This breed takes its name from its characteristic short horns. It is also known in some localities as the Durham, from one of the counties in which it originated. The original home of the breed is in northeastern England, in the counties of Durham, Yorkshire, and Northumberland, especially in the valley of the River Tees. In this region the breed was improved and developed, and from here it has spread over almost the entire civilized world.

The exact origin is veiled in obscurity. The Romans, Saxons, Danes, and Normans in succession brought their cattle to England and mixed them with the native stock. After the invasion of the Normans there was little interchange of cattle for several centuries, during which time the animals in the rich valley of the Tees probably increased in size, owing to the favorable conditions of climate and food.

It is known that a large type of cattle existed in this region several centuries before the development of the modern Shorthorn in the eighteenth century. Early in the eighteenth century there were two general types, known as the Tees-water and the

Holderness. About this time, it is believed by most authorities —but disputed by others—bulls were brought from Holland and used in some of the herds from which descended the improved Shorthorns.

The beginning of the improvement which resulted in the modern Shorthorn began about 1780, when Robert and Charles Colling began their breeding operations, which lasted until 1818. These men are often spoken of as the founders of the modern Shorthorn breed. Shorthorns as bred by the Colling Brothers were generally good milkers, and this quality was considered by them as an important characteristic of the breed, to be retained as far as possible. At the same time, they were more interested in developing the general symmetry and beef-making characteristics. They followed the methods of Robert Bakewell closely, practicing in-and-in-breeding constantly.

Toward the latter part of the eighteenth century, Thomas Bates began breeding Shorthorns. He aimed constantly to develop a superior combination dairy and beef animal, and he succeeded to a marked extent. Most of the best milkers among the Shorthorns at present are descended from animals of this breeding.

The Booth family began to breed Shorthorns about 1790. They emphasized beef production, and paid little or no attention to the dairy qualities.

Amos Cruickshank, who began breeding in 1837, developed the so-called Scotch type of Shorthorns, which are characterized by superior beef qualities and decidedly inferior dairy qualities.

The original Shorthorns were counted good dairy animals. Some very creditable reports are given regarding daily or weekly production of certain cows in the time of the Collings. It would appear, however, that even then the breed had the characteristics of the Shorthorn of today: milking heavy for a short time, but lacking persistency.

The Shorthorn cows brought to America during the early importations were usually at least fair, and some were exceptional, milkers. On account of the general use of this breed for exclusive beef production in America, the dairy qualities were generally neglected, and most breeders aimed only at the best beef animal. This condition was further strengthened by the importations of the Scotch type. As a result, the typical pure-bred Shorthorn as found today in America as a rule has no claim whatever to be called a dairy animal. In a few localities the original dairy qualities have been preserved, and it is still possible to find first-class dairy animals in this breed in these localities. Within recent years there has been a revival of interest in the milking qualities of this breed, and a considerable number of herds of pure-bred Shorthorns are now to be found where all cows are milked and records of individual production kept.

Breed Characteristics. The Shorthorns vary in type from the extreme beef conformation to the dual-purpose, with a few of real dairy form. The latter are exceptional, and not typical of the breed in America. Shorthorn cows of the milking types weigh usually between 1,200 and 1,350 pounds when mature. A typical cow of this type loses considerable flesh when in milk; when dry she fattens rapidly, and shows much more of the beef characteristics. Red, white, and roan are the typical Shorthorn colors, and the disposition is quiet and gentle. The reproductive functions are only medium. More difficulty is experienced with failure to breed than with certain other breeds, and the calves at birth are only medium in vigor. At birth, calves range between 70 and 80 pounds in weight and represent about six per cent of the weight of their dams.

Dairy Characteristics. While the Shorthorn breed is not counted among the dairy breeds, still enormous numbers of grades of this breed are milked, especially in the butter-producing states of the Mississippi valley. As in the case of other breeds, it is difficult to get satisfactory data concerning the production of Shorthorn cows under practical farm conditions. A compilation of records published by experiment stations shows an average of 6,017 pounds of milk and 218 pounds of fat in a year for thirty-seven animals represented. The average per cent of fat for these animals is 3.63, and of total solids 12.85. These figures are about typical of results in herds in which careful attention has been paid to selection of the individual animal, and in which good conditions of feeding and management are maintained. Such an average is considerably higher than that realized on the ordinary farm. From the data available it is safe to say that a herd of dairy Shorthorns should be expected to average between 5,000 and 5,500 pounds of milk and from 200 to 225 pounds of fat. A high figure for a herd average would be 6,500 pounds of milk or more, while less than 5,000 pounds as an average indicates lack of care in selection of individuals or improper conditions of feeding and management. The fat content will vary as a rule between 3.50 and 4.25 per cent with an average of not far from 3.8 per cent.

The Shorthorn cow, like others of dual-purpose breeds, generally lacks persistency in milk production. It is not uncommon, for example, that a Shorthorn cow produces 40 to 50 pounds of milk a day when fresh, but declines so rapidly after four of five months that her total product for the year may be not over 4,000 and in seven or eight months she may be dry. There are some notable exceptions to this by certain individuals of the breed which show all the persistency in milk production of the more highly developed dairy breeds. Perhaps the most marked difference between herds that show a low to a medium production and those that under the same conditions show a high production is a difference in persistency of milk flow. In color of milk and in size of fat globules, Shorthorn milk ranks next to that from the Channel Island breeds, rating between the Channel Island and the Holstein milk.

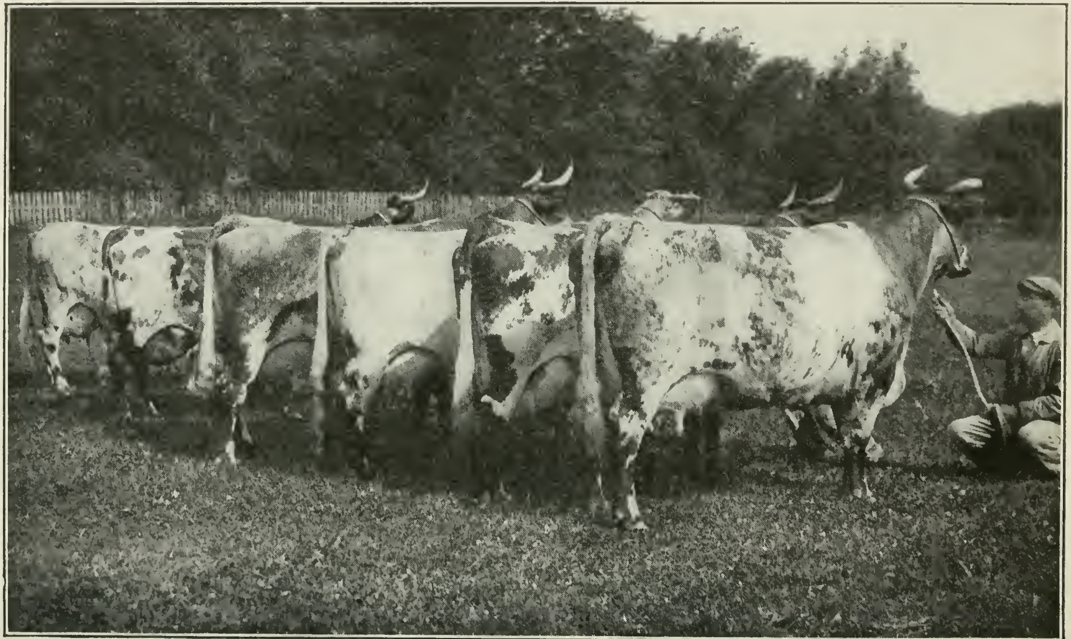


FIG. 22. A group of Milking Shorthorns. The cows in this remarkable group have milk records from 8,752 to 17,241 pounds. The second one from the right, Doris Clay, for some time held the highest fat record for the breed. Note that some of them show more dairy than beef type.

Shorthorns in England. The dairy Shorthorn is the principal dairy cow of England today and the typical Shorthorn cow of England, as well. Professor Long says: "The milk-producing farmer has studied how to increase the flow of milk while maintaining the characteristic feeding qualities of the breed, and has succeeded. On the other hand, the great pedigree breeders have subordinated milk to flesh development, form, quality, and even color. Where sires and dams are of equally renowned milking character, the Shorthorn is preeminently the best dairy cow in the best dairy country in the world."

The milking qualities of the English Shorthorn are shown in a remarkable way by the results of the milk and butter tests made at the London Dairy Show. During the past twenty years, first place in both milk and butter production has been won in a majority of cases by either a registered or a non-pedigreed Shorthorn. Two hundred and thirty-six pedigreed Shorthorns in these tests averaged 48 pounds of milk and 1.82 pounds of fat a day. One hundred and twenty-six non-pedigreed Shorthorns averaged 51.8 pounds of milk and 1.95 pounds of fat a day.

Breed Organizations. The registration of pure-bred animals of this breed is in the hands of the American Shorthorn Breeders' Association, whose headquarters are in Chicago.

In 1910 a group of Shorthorn breeders interested in developing the milking strains of the breed organized the Dairy Shorthorn Breeders' Association, which functions as an auxiliary to the American Shorthorn Breeders' Association.

In 1915 another group of breeders, who believed the interests of the milking Shorthorns could be best served by a separate organization, established the American Milking Shorthorn Breeders' Association. Another object in view was to make it possible to utilize the non-pedigreed Shorthorn of England which includes the best developed dairy types of the breed but which have not been imported to the United States on account of the fact that the American Shorthorn Association accepts only those imported animals which are registered in the English Herd Book.

The American Milking Shorthorn Association provides for the registration of Shorthorns of milking qualities. This is the only breed association in which milk production is part of the elegibility for registration. Elegibility of the offspring of recorded cows is based upon the milk production of their dams. Provision was made for entering as foundation stock for a limited period animals imported from England, though not recorded, that could be shown to be from at least four generations of recorded sires; also, grade Shorthorns bred in America, and likewise descended from several generations of pure-bred sires.

Advanced Registration. A few years ago the American Shorthorn Breeders' Association established an advanced register under the name of Record of Merit. The requirement for admission is the production of a specified amount of milk or of butter fat. Starting at the age of 30 months, a heifer must produce 5,250 pounds of milk or 210 pounds of fat within the year. Three pounds of milk or one-tenth pound of fat is added to the requirement for each additional day of age. At maturity 5 years or above, the minimum figure is 8,000 pounds of milk or 300 pounds of fat.

Private records are also published in a separate list. The highest records reported by the American Shorthorn Breeders' Association up to the present are as follows:

	Lbs. Milk	Lbs. Fat
Snowdrop	15,550	692.3
Buttercup 2d	15,608	657.7
Doris Clay	17,241	653.7

Nearly thirty official records of above 500 pounds of fat are recorded.

Mollie—owned in Quebec, Canada—has a record of 16,815 pounds of milk and 711 pounds of fat. Melba 15th of Darbalora

—owned in South Wales, Australia—is credited with 29,423 pounds of milk and 1,316 pounds of fat in a year, which ranks her in first place among dairy Shorthorns.

Red Polls

Origin and Development. This breed originated in Norfolk and Suffolk—adjoining counties in the eastern part of England. They are low and flat, with some marsh land. The soil is naturally diversified, although rather poor, but it has been brought to a high state of fertility by good management. About 80 per cent of the area is tillable. The climate is generally typical of England, although the rainfall, which averages twenty-six inches per year, is less than the average for England.

The origin of this breed, like that of most other breeds, is uncertain. It seems, from the best information obtainable, that they have been bred up from the cattle native to these two counties since a time more remote than accurate historical records go. Improvement began in the latter part of the eighteenth century, as part of the widespread movement of that time for improved livestock.

Mr. Euren, the first Secretary of the Red Polled Herd Book, is of the opinion that the original cattle of this type were brought to England by the Danes who settled in this part of England in the fifth century. He does not believe there is any foundation for the statement often made by writers that Galloway blood was introduced from Scotland by bringing Galloway bulls. However, Youatt, the well-known early English writer on cattle, and Wallace, a recent writer, attribute the improvement largely to this source.

In 1804 Young wrote an account of the agricultural conditions in Norfolk and Suffolk, in which he describes the cattle of Norfolk as a small, red class of cattle, partly polled and partly horned. At this time they were bred more for beef than for milk, and made a poor impression on the writer. Later, the horns were bred off by using, probably, either Suffolk or Galloway bulls for the purpose. The beef qualities were considerably developed, according to some authorities, by introducing Devon blood. In 1818 the cattle of Norfolk began to be known as Norfolk Polled.

The cattle of Suffolk from the earliest records were considered exceptional milkers. They were rather small in size, red, brindled, dun or mouse colored, and always polled. Young, writing in 1804, describes them as follows: "A clean throat with little dewlap, a clean head, thin legs; a very large barrel, ribs tolerably springing from center of the back, but with a heavy belly; backbone ridged; chin thin and hollow, loin narrow; udder large, loose and creased when empty, milk veins remarkably large. A general habit of leanness, hip bones high and ill covered with flesh."

According to the same writer, yields of five gallons of milk per day were not uncommon for entire herds while on pasture. The breed had the reputation of being the heaviest milkers in England for their size, and of being especially adapted for poor pastures and unfavorable surroundings. The Suffolk cattle were always bred mostly for milk. The cattle of this county became known as Suffolk Polled. The colors other than red were bred out during the early part of the nineteenth century.

The cattle of Suffolk and Norfolk were developed along the same lines, until about 1846 it was generally recognized that the two types were so near together that they were practically the same. The division in name continued until 1862, when at the Royal Agricultural Society Show they were first classed together under the name, Norfolk and Suffolk Polled. In 1882 the name was shortened to the present name of Red Polled.

At the present time the breed is found largely in the two counties where it originated and to some extent in Australia and New Zealand. They are not found on the Continent of Europe. They are used in England as dual-purpose cattle, and in that class rank about the same as the non-pedigreed Shorthorns.

Importation and Distribution in America. Cattle from the home of the Red Polled breed were undoubtedly brought to America during the colonial days, but they were not kept pure. These early importations are probably responsible for the muley red native cows often seen, particularly in the Eastern States, some years ago. The first importation of the improved type was brought to America in 1873 by Gilbert F. Tabor, of Patterson, New York, who also made several later importations. Several importations were made between 1880 and 1890, and from these mentioned are descended most of the cattle of this Red Poll breed now in America.

They are now found in all or nearly all, the states of the Union, but they are most numerous in Ohio, Illinois, Michigan, Iowa, Wisconsin, and Kansas. The English Red Polled Herd Book was first issued in 1874. The Red Polled Cattle Club of America, organized in 1883, registers the breed for America.

They have won their way entirely upon their merits, and are increasing rapidly in those states where dual-purpose cattle are in demand. They are the most typical and most popular of the real dual-purpose breeds.

Breed Characteristics. In size, the Red Polls rank below the Shorthorn and other heavy beef breeds. The cows weigh between 1,200 and 1,300 as a rule, but occasionally one reaches 1,500 or more. The bulls range from 1,800 to 2,200, and occasionally individuals reach 2,500 at maturity.

In color, the Red Polls are a deep cherry red. White may appear on the tip of the tail, the udder may be white, and a few small white markings are allowed on the belly. White on any other part of the body disqualifies the animal, as does a black nose or even abortive horns.

In form, the Red Polls are typical dual-purpose cattle. In general, the conformation is about midway between the dairy

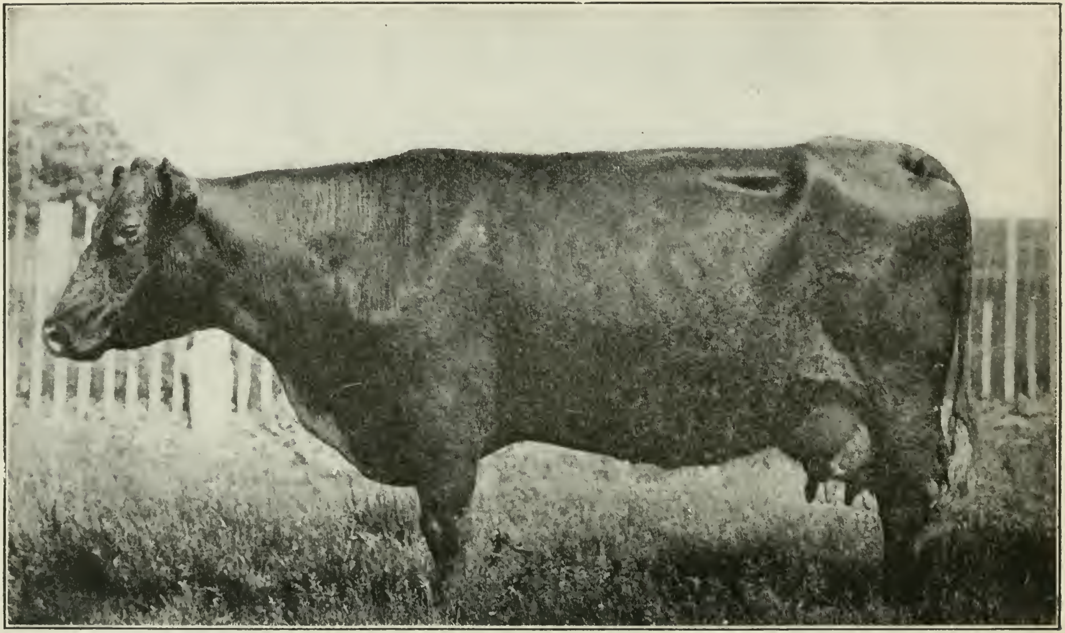


Fig. 23. Red Polled cow. A good representative of her breed. The Red Polled is the most typical dual-purpose breed. They are fair producers of both milk and beef, but do not excel in either

and beef types as typical of the dual-purpose breeds. The general form is parallelogrammic. The head and neck are lean and of dairy type, with the characteristic poll. The hind quarters are of moderately good beef form. The udder is often somewhat pendulous, and the fore quarters frequently deficient and irregular in shape. The udder is seldom meaty in character, but usually elastic and mellow in quality. The milk veins and milk wells are usually fairly prominent. The teats are inclined to be irregular in shape, and often large, even to the extent of being somewhat objectionable at times.

There is considerable variation in type between different herds of this breed, depending upon the purpose for which they have been bred. In come cases they are bred for beef production alone, and the cows are then not milked. In other herds the dairy qualities are given first place. Such practice results in wide variations in form and capacity for milk production in different herds. The judging of Red Polls in the show ring has usually been done mainly from the beef standpoint which tends to develop the beef qualities at the expense of the milking qualities. The Red Polled Cattle Club has formulated a scale of points to assist in establishing a more definite type.

Red Polls are fair breeders, ranking about equally with the Shorthorns in this respect. In regard to early maturing qualities they probably rank rather lower than the Shorthorns.

Beef and Milk Production. The Red Polls are a real dual-purpose breed, according to the definition given, since they are quite uniform in their ability to produce a fair amount of milk and are salable for beef at a creditable price.

As compared with the typical Shorthorns found in America the Red Polls are on the average, superior milkers, while as regarding beef production the conditions are reversed. The breed ranks well as beef producers, but does not win highest honors in competition as beef animals. The steers are satisfactory feeders; they gain rapidly and bring a creditable price.

The steers are not so blocky and compact as those of the strictly beef breeds, and usually they are longer legged. The cows fatten rapidly when they are not producing milk.

Red Polls rank high in milk production for a dual-purpose breed. Few records have been published of cows owned by experiment stations, but those available show a yearly average of 5,900 pounds of milk having a fat test of 4 per cent, equivalent to a fat yield of 236 pounds. Under good farm conditions a herd of Red Polled cows should average yearly from 5,000 to 5,500 pounds of milk and from 200 to 225 pounds of fat. Good specimens should be expected to produce up to 10,000 pounds of milk in a year. In yield of milk this breed is excelled by the Holstein and Ayrshire, and in England by the Dairy Shorthorns.

Milk of the Red Polled breed has about the proper composition to make it most suitable for market purposes or cheese-making. In color of milk and butter it ranks about equally with the Shorthorn, below the Jersey and Guernsey, and above the Holstein and Ayrshire.

Advanced Registry. A plan for making official records was adopted by the Red Polled Cattle Club in 1908. The tests are conducted, as in the case of the other breeds, under the supervision of a representative of the Agricultural College in the state where the herd is located. The supervision covers two days of each month, the owner keeping the milk record between the test periods. The number of cows tested for advanced registration has not been large as compared with the numbers from the dairy breeds, but the records made have been very creditable and have exerted a marked effect upon the popularity of the breed. The highest record for the breed is held by Jean Du Luth Beauty, with a production within a year of 20,280 pounds of milk containing 891 pounds of fat. This cow weighed 1,750 pounds at the completion of the test. Thirty animals owned in the same herd as the record cow have official records averaging 460 pounds of fat a year.

CHAPTER XI

GENERAL CONSIDERATION IN SELECTING A BREED

The Choice of a Breed. The first question which arises in starting a herd is the choice of the breed. There is a tendency to attach too much importance to this decision. The important thing is to decide upon the breed after weighing all the facts available, and then to continue with the one chosen unless some unusual condition arises which justifies a change. Minimizing the importance of breed selection should not be interpreted as signifying that breeds as such are unimportant. Quite the reverse is true. It has been pointed out in a previous paragraph that breeds represent the efforts towards improvement by generations of breeders and that the use of a well-established breed makes it possible to take advantage of all that has been done in the past and to start on a par with those at present engaged in this work. Warning is also given elsewhere against the crossing of breeds, as it is a practice which leads to deterioration of the herd rather than to improvement.

The leading dairy breeds, however, do not differ much in real efficiency, as shown in a later paragraph. If one farmer has not made a success with dairy cattle and another has made a marked success, the difference in outcome is seldom to be attributed to the choice of breeds. The man who is a failure with one breed ordinarily will meet a similar fate with another. The success or failure of a dairy-farming enterprise is seldom to be attributed to the breed chosen but usually to other causes, such as failing to cull out unprofitable cows, and improper methods of feeding and management.

There are certain considerations which may be taken into account in choosing a breed and the most important may be listed as follows:

1. Breed of cattle most common in the community.
2. Form in which product is to be marketed.
3. Average production of milk and fat.
4. Original cost and probable demand for surplus animals.
5. Climate, food supply, and topography of farm.
6. Economy of production of milk and fat.
7. Breeding qualities of the cows.
8. Vigor of calves.
9. Beef value of discarded cows and adaptability of calves for veal.
10. Preference of the breeder.

Most of these points have been discussed in connection with the descriptive matter concerning the breeds.

The advantages to the farmer of using the same kind of stock as his neighbors should be given far greater prominence than his own preference or any small points of difference between the breeds. If the farmer expects to sell milk on the wholesale market, his choice would hardly fall upon the Jersey or Guernsey unless the market is the exceptional one that will pay enough more for rich milk to justify its production. For milk production the Holstein, Brown Swiss, or Ayrshire would come into strong consideration on account of their large and economical milk production. If the location is such that cream will be sold, the Channel Island breeds should receive careful consideration on account of their well-known economical use of feed for the production of butter fat. Under these conditions the probable value of skim milk for pigs and calf feeding is still another consideration and might cause the choice to fall upon the Holstein on account of the large production of this valuable by-product. When selling butter fat or cream the total quantity of fat and not the percentage of fat in the milk is the important factor. For cheese-making and for market milk the total solids and not fat alone are wanted.

It is impossible to give figures that are satisfactory regarding the relative production of the breeds under practical farm conditions. The results from official testing are available but represent conditions far removed from those existing among the herds where the great mass of market product is produced. It may safely be said that, between the breeds, the variation in average production is not great, and it is far less than that between the good and the inferior animals within the breed.

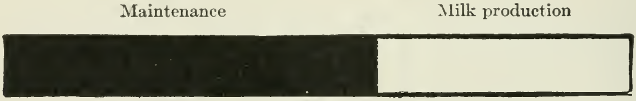
The original cost should receive some consideration but can be easily overemphasized since the herd is ordinarily maintained by raising young animals, and the expense for the foundation animals has to be met but once. The probable demand for surplus animals is difficult to estimate in advance. It does suggest, however, the desirability of using a breed well known to the public and one popular in the region where the herd is located.

Facts concerning the relation of the breeds to abundant pasturage, hilly pastures, and warm climates have been given in connection with the individual breeds. The economy of milk and fat production is closely related to the form in which the product is to be marketed and should be considered in that connection. It is well to keep in mind that the breeds having the largest average production are the cheapest producers as well. The breeding qualities of the cows and the vigor of the calves are important and should receive due consideration. The beef qualities of discarded cows and the adaptability of the calves for veal are of minor importance in a herd representing a special dairy breed. A difference of even $25 in the beef value of a discarded animal is a small consideration, if in order to get this additional return an inferior cow has been kept four or five years with possibly a greater loss in milk production each year than her additional beef value when discarded.

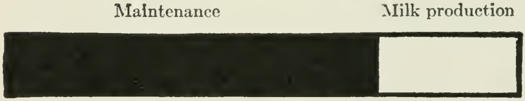
The individual preference of the man who is about to start a herd should not weigh too heavily in making a choice, since a person who is a born stockman will soon prefer the breed with which he is working, and his preference will change quickly, as a rule, if a breed is selected which was not his first choice.

The Relative Efficiency of the Breeds. In presenting the merits of a breed, its adherents often make claims of special efficiency in the matter of fat production or milk production as the case may be. The idea is often held that one breed or another in some way makes better use of its food than others. The present purpose is to analyze the situation and to show how much truth lies in such claims and to give explanation of such of these statements as can be substantiated. In order to understand the questions involved it is necessary to have certain fundamental facts clearly in mind.

Between high and low producers. It is well known that there is a wide contrast between a heavy producing and a low producing cow in the amount of food required to produce a pound of milk or fat. The explanation in detail is reserved for a later chapter, but it must be anticipated to some extent at this point. An animal that produces 300 pounds of fat in a year does so at a lower feed cost per pound of fat than does an animal of the same size and breed producing 150 pounds. The heavier producer uses more feed but less in proportion to her production. The explanation is that the feed used to maintain the animals—that is, keep up the body—is the same for both. The heavier producer has a great capacity for work and after supplying her



Use of ration by cow producing 300 pounds of fat.



Use of ration by cow producing 150 pounds of fat.

FIG. 24. The economy of high fat production. The cow producing 300 pounds of fat uses only about 25 per cent more feed than is required to produce 150 pounds by a cow of the same size.

own maintenance uses more feed for making milk than does the small one.

Fig. 24 will assist in conveying these facts. This graph illustrates the division of the ration between maintenance and milk production for two Holstein cows, one producing 300 pounds of fat, the other 150 pounds in a year. It will be noted that the additional feed used by the heavier producer all goes to milk production and while she uses a greater quantity of feed the amount to the pound of fat is evidently decidedly less.

Maintenance requirement in proportion to size. It is well established that the feed necessary to maintain a dairy cow—that is, to preserve a uniform weight when no milk is produced—varies with the size of the animal. According to the German feeding standards the maintenance requirement is in direct proportion to the weight. Armsby, however, finds that this is not exactly the case, the smaller animal having a slightly higher maintenance requirement in proportion to size. This difference is so small, however, that it may be ignored in a practical consideration. From this point of view a cow weighing 900 pounds will require three-fourths as much feed for maintenance as will one weighing 1,200 pounds.

Breed differences in digestion of feed. The evidence available shows that the breed of the animal has no relation to its ability to digest food. In an experiment by the author a digestion trial was made with cows representing four breeds and receiving exactly the same ration. The results were as follows:

	Per Cent Digested
Holstein	65.34
Ayrshire	64.31
Jersey	66.27
Dairy Shorthorn	65.52

It is surprising how close all came to the same figure. These results are, in fact, all within the limit of error, and the variations are too small to receive any attention. This is in line with the conclusion of Armsby, who states: "The recorded data fail to indicate any material difference in the digestive power of different breeds or between pure-bred and scrub animals."

Breed variation in cost of fat production. In the discussion of the Jersey and Guernsey breeds, it is pointed out that, on the average, cows of these breeds can produce a pound of butter fat at a slightly lower feed cost than can a Holstein or Brown Swiss. There are two reasons for this: (1) the most important is that the Jersey and Guernsey are smaller animals and the amount of feed required to maintain the cow is less than for a Holstein or Brown Swiss. (2) These breeds produce richer milk; in other words, they produce less milk along with the fat.

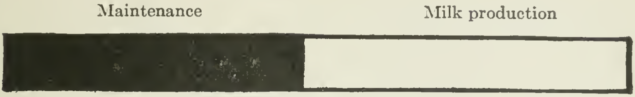
The author fed cows of different breeds for an entire lactation period upon uniform rations. From these data figures for individual cows are selected which illustrate in a typical manner the case as between the Jersey and the Holstein breeds:

	Lbs. Weight	Lbs. Milk	Lbs. Fat	Lbs. Digestible Nutrients per Lb. Fat
Holstein	1,219	11,986	407	16.1
Jersey	950	6,033	367	14.1

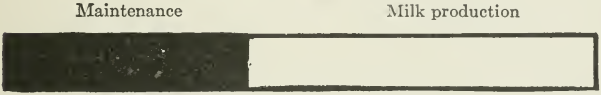
These data show that the Jersey used less feed to the pound of fat produced than the Holstein. The principal reason for this was that the Holstein, weighing 1,219 pounds, on account of her greater size required more feed for maintenance than the Jersey, which weighed only 950 pounds.

This is illustrated by Fig. 25 in which the black is the portion of the ration used for maintenance and the unshaded that used for milk production.

The difference between the 16.1 pounds of digestible nutrients used by the Holstein per pound of fat produced and the 14.1 used by the Jersey is thus to be attributed to a combination of a lower maintenance for the Jersey and less skim milk produced in proportion to the fat.



Use of food by Holstein cow



Use of food by Jersey cow

Fig. 25. Graphic illustration of the influence of the size of the animal as a factor in economy of production. If two cows produce the same amount of fat, the smaller cow will use less feed per pound of fat on account of the smaller maintenance requirement.

Breed difference in feed for milk produced. It is generally recognized that the Holstein breed is preëminent in economy of milk production, although, as in the case of the cheaper fat production by the Channel Island breeds, the importance of this fact is often overestimated.

In the data from the same cows, used in the comparison in the previous paragraph, the digestible nutrients to the hundred pounds of milk and per pound of total solids is as follows:

	Holstein	Jersey
Pounds milk	11,980	6,033
Per cent fat	3.40	6.09
Digestible nutrients consumed per 100 lbs. milk	54.7	87.7
Digestible nutrients consumed per lb. total solids	4.8	5.6

The data show that the Holstein used 9.3 pounds of nutrients per day for maintenance, while the Jersey used only 6.2. If the feed required to the pound of fat is calculated, after taking out what was necessary to maintain the animal we find the Holstein used 7.7 pounds of digestible nutrients to the pound of fat as compared with 8.2 pounds for the Jersey. This shows that the Holstein really was making as good use of her food as the Jersey. The reason the Holstein was using a trifle more feed for each pound of fat was mainly that she had to use more feed to maintain herself. It is clear that if a 950-pound cow will produce as much as one weighing 1,200 pounds, the amount required for a pound of fat will be less by the smaller animal.

The second factor influencing the feed cost of the fat also comes into account here. For each pound of fat in her milk the Holstein produced 2.3 pounds of other solids and the Jersey 1.6 pounds.

Feed is required for the production of the solids not fat —which may be thought of as skim milk in this connection— as well as for the fat. Since the Holstein produced more skim milk in proportion to her fat, the feed cost of the milk—if all is charged against the fat—will tend to be higher for the Holstein. In this case it is clear there are two reasons for the cheaper production per 100 pounds of milk by the Holstein. These are the larger production and the lower per cent of fat. The lower food requirement for the production of total solids by the Holstein is accounted for by the larger production in proportion to the size of the cow and the lower proportion of fat in the solids.

General considerations. When all the facts are considered, it will be found that the question of efficiency of breeds from the standpoint of feed requirements resolves itself largely into one of comparative size of the animal and yield of milk and fat, to a minor extent the proportion of skim to fat—in other words, the richness of the milk—is involved. If a small cow will produce as much milk or fat as a larger one, she will do it cheaper, because there is less cow to maintain. If the larger animal produces enough more milk than the smaller cow so that the proportion of her ration used for maintenance is no larger than with the smaller, the feed cost per pound of fat will be just as low. In the case of two animals of the same size which produce milk of the same quality, the larger production, although it calls for more feed, is bound to be the cheaper.

Conclusion. The main difference in the efficiency of cows as milk and fat producers is the difference between the low producer and the high producer, and bears no relation to breed. There is no difference in the efficiency of breeds so far as digesting feed is concerned or in the use of feed as a whole if everything is taken into account. Some require more for maintenance on account of greater size; others, by producing milk low in fat, use more feed for production of solids not fat.

The Channel Island breeds are cheap producers of fat; first, on account of their smaller size in proportion to the amount of fat produced; second, due to the smaller amount of skim milk, or solids not fat, produced along with the fat.

The Holstein breed produces milk at the least feed cost per 100 pounds; first, on account of the larger milk yield which overbalances the higher maintenance costs; second, on account of the lower fat percentage—that is, the smaller amount of fat in proportion to the total milk produced.

Breed differences in the use of roughage. The statement is often made that a marked difference exists in the utilization of roughage by different breeds. Superiority in this respect is generally claimed for the Holsteins by partisans of this breed. Clearly there is no advantage in the consumption of large quantities of roughage unless the need for concentrates is correspondingly less. The real question therefore is the possibility of one breed having the ability to utilize roughage to the extent of securing a larger proportion of their nutrients from this source.

Experimental results. Woll[1] studied the records of feed consumed and milk and fat produced by a large number of cows

[1] Research Bul. 26, Wis. Exp. Station (1912).

entered in the Wisconsin Dairy Cow Competition. Presumably the best herds in the state were represented and the owners used their own judgment as to feeding practice. Woll made his calculation in terms of "feed units." The source of the feed units as between the roughage and concentrates was as follows:

Number of Cows	Breed	Average Yield of Lbs. Fat	Percentage of Feed Units from Roughage
50	Holsteins	524	47.6
50	Guernseys	432	53.1
50	Jerseys	371	59.8

In this case the proportion of nutrients from the roughage was decidedly less for the Holsteins than for either the Jersey or the Guernsey; but is to be accounted for by the higher production, since it is a well-established fact that the higher the production of milk and fat the greater the proportion of nutrients that must come from concentrates. The twenty-five poorest Holsteins with a production of 374 pounds of fat may be compared with the fifty average Jerseys producing 371 pounds of fat. In this comparison the Holsteins derived 51.3 per cent of their nutrients from roughage and the Jerseys 59.8.

A comparison from feeding records reported by Savage[1] shows that five Jerseys producing on an average 1.29 pounds of fat daily derived 51 per cent of their total nutrients from roughage compared with 52.8 per cent from roughage by a group of Holsteins producing on the average 1.33 pounds of fat daily. It should be noted that these data are taken from herds well fed and producing liberally.

This does not exclude the possibility that on a roughage ration alone, for example, corn silage and alfalfa hay, some breed characteristic might appear and one breed be able to maintain a higher level of fat production than others on such a ration. Some evidence of a breed characteristic has been found in the use of roughage during the growing period of the heifer. Data taken by the author show that when rations of alfalfa hay alone, or alfalfa hay and corn silage, were used, animals of the Holstein breed ate a larger quantity and made better gains in weight in proportion to normal gain.

---

[1] Bulletin 323, Cornell University Experiment Station.

Conclusions. The Holstein cow, in common with other large breeds, is a liberal consumer of roughage, exceeding the smaller breeds in total consumed, but this greater use of coarse feed is to be attributed to her greater size. An average sized Holstein weighs 40 per cent more than the other extreme of the common dairy breeds, the Jersey, and it is not surprising, therefore, that her total roughage consumption is greater. According to the feeding practice of both experiment stations and practical breeders, cows of this breed when fed for liberal milk production do not receive any greater proportion of their nutrients in the form of roughage than do the other breeds. If there is such a thing as a breed characteristic, regarding the use of roughage, it is limited to the growing heifer and the cow in milk when the ration is practically all in the form of roughage and the production, therefore, very limited.

Community Breeding. While progress has been made in the development of dairy cattle in the United States, the improvement is disappointingly slow. While the best herds are fully equal in production to the choicest representatives of the breeds in their native homes, the average production of all breeds, however, is far below that of the same breeds in the localities in Europe in which they originated. Possibly several causes contribute to this end and among these the intermingling of breeds in almost every locality in America. Although Europe has a large number of breeds—over forty being described on the Continent alone and twelve for Great Britain—the common condition is to find but one breed in a locality. This is a decided contrast to conditions in America, where three or four breeds of cattle may be found within the limits of a small neighborhood. Within recent years the conviction has been growing in this country that one reason for the much higher average production of dairy cattle in Europe is a better development made possible by this grouping of breeds into localities.

As an outgrowth of this growing conviction has come a definite policy on the part of those in a position to guide to some extent the development of the dairy industry in this country to encourage the development of dairy cattle breeding communities. When a community takes up such an enterprise in a more or less organized manner, it is spoken of as community breeding. Outside of organized community breeding activities there is clearly a tendency for such a grouping of breeds by localities as the result of several factors, but this movement advances slowly unless organized.

Community preference as a basis for breed selection. As pointed out in connection with the discussion of breed selection, the first consideration in the selection of a breed by the beginner should be the breed most generally used in the locality. Instead of selecting a breed because it is not well represented in the community, as is sometimes done under the impression that the demand for surplus stock will be better, it is much wiser to develop a herd of the same breed that already predominates in the locality.

If dairy cattle development has not reached the point where any community preference has become manifest, the choice will necessarily be made on other grounds. It is possible that the judgment of an entire community will be wrong in this matter, but a beginner should not take this position without very good reasons.

Where a community preference has not been developed, it is often possible for a group of no more than five or six, who will work together for the purpose, to definitely turn the attention of an entire locality to the breeding of one breed of livestock to the great benefit of all concerned.

Community organizations. The first organization for the express purpose of developing a community as a breeding center was the Waukesha Guernsey Breeders' Association, organized in 1906 by less than a dozen men of that county in Wisconsin.[1] The possibilities of such an organization were so quickly recognized that others followed rapidly. By 1910, thirty similar organizations were in operation in Wisconsin, and by 1920 the number had increased to 160. By this time ten sales pavilions had been built and twelve more were under way. This type of community organization has spread to other states, particularly Minnesota; but Wisconsin still retains the leadership in this activity. Experience has shown these organizations to be successful to the extent that individual members are willing to subordinate their own interests in part to those of the community. In the successful communities the spirit of coöperation among the members is striking. A buyer visiting one of these communities is treated with the greatest courtesy and special attention shown to giving him full opportunity to visit as many herds as he may desire. Each member is careful to refrain from adverse criticism of the stock owned by others and from unduly directing attention to his own stock. The general attitude is of giving assistance to the buyer in finding what he wants regardless of from whom the purchase is made.

Activities of a community organization. The primary purpose of such an organization is to promote the welfare of the community by the improvement and development of a certain breed of livestock and the establishment of coöperation and cordial relations between its members that will insure the most successful economic results. As a means to this end an association of this kind will be interested in most of the activities listed:

---

[1] **Humphrey, G. C., Bulletin 189, Wisconsin Experiment Station (1906).**

1. Increase in number of breeders of the particular breed in the locality.
2. Extension of the use of pure-bred sires.
3. Organization of calf clubs among boys and girls.
4. Holding public sales for its members.
5. Eradication of disease from the locality.
6. Establishment of cow testing association and the stimulation of official testing.

During the early stages of a community organization the objective is securing a large number of breeders of the same class of cattle in the locality and developing the spirit of community coöperation. As the quality of the livestock improves, the reputation of the community for high-class animals may be established by suitable advertising in the agricultural press, and by the holding of shows, sales and other means.

General meetings with capable speakers are held at intervals usually on the farm of a member. When the development of the community reaches a suitable point public sales may be held with advantage and in time a sale pavilion may be needed.

Sale of surplus stock. One object of a community organization is to facilitate the sale of surplus stock whether it be grade or pure-bred. When one community has a large number of animals of the same breed for sale, it soon becomes widely known and a good market for that class of animals is established. Buyers are always attracted by the possibility of buying a number of cattle in one neighborhood, and surplus stock can be disposed of much more readily than where animals are widely scattered. As a result of community breeding certain localities become known as Holstein centers, others as Jersey or Guernsey localities and buyers from a distance visit these localities knowing they will be able to find what they want among the large number available.

It is believed that the average price received for surplus animals is fully 20 per cent higher in communities having a reputation which attracts buyers. When the stock in the community is well developed it may be advisable to inaugurate public sales held at regular intervals. However, experience has shown that it is a mistake to hold a sale until a sufficient number of high-class animals are available. A sale of culls is a detriment to the future development of the community.

Stimulation for improvement. One of the most important advantages experienced when a community takes up the development of a certain breed is the more rapid advancement made in everything that pertains to cattle breeding and management. This is largely the result of the stimulation as well as the information the individual breeder receives from his association with others interested in the same subjects. Regardless of how much ability or education a person may have, he needs the constant help and counsel of others interested in the same line. When a man is the only breeder of a certain class of livestock in the locality he seldom makes much progress either in knowledge of his business, or in building up a reputation which will bring buyers for his surplus. He has no one at hand with whom he can talk over his problems or with whom he can compare results. Often he retrogrades and finally gives up the struggle.

On the other hand, a number of breeders in the same community, especially where a community organization functions, exchange ideas, compare results, and learn from each other's successes and failures.

Exchange of breeding stock. Another of the decided advantages of community breeding is the opportunity it affords to make better use of high-class breeding animals. One of the deplorable facts concerning present practices in breeding cattle is the limited use made of pure-bred sires. One reason for this is the feeling on the part of the farmer that he cannot afford to pay a good price for a bull when the herd is small and as a rule the bull has to be sold for beef at the end of two or three years. When there are a large number of breeders of the same breed in a locality it is possible to exchange bulls and by this means to make a more extensive use of high-class animals than would be possible otherwise. This possibility also increases the possibility of finding bulls of great transmitting ability before it is too late to make use of them.

Testing and disease eradication. The conduct of official testing has become a necessary part of the business of raising pure-bred dairy cattle for sale. It is generally easier to get official testing done when there is a group in the same locality, especially when these are members of an association. If it is desirable to organize a cow testing association to test grade cows, a group accustomed to work together are in a position to go ahead to the best advantage. The control and eradication of tuberculosis and abortion can also be handled much better where local associations are in existence.

Starting the Herd. The successful dairy herd, in common with the successful business enterprise of other kinds, usually is started on a small scale and increased as the owner adds to his capital and experience. The plan to be followed will depend upon conditions such as purpose in view, knowledge of the business, and capital available. It is seldom advisable for a beginner to take up the breeding of pure-bred cattle without first having some experience with grades. This paragraph deals with the subject from this standpoint, leaving for a later chapter a consideration of the breeding of pure-bred herds.

Assuming that a beginner has already decided what breed he wants, what is the best course to pursue? Should he undertake by using good bulls to build up from common cows, some of which may contain more or less blood of beef breeds, or should he buy well-bred animals of the breed he has selected? and if so how should these animals be selected?

A numerous class is represented by a farmer who lives in the corn belt, or the south, or any part of the country where dairying is not as yet well developed. This farmer does not expect to become a dairyman in the sense of making that his exclusive business. He expects to operate a general farm and milk as many cows as one man can handle. He is not certain just how far he will care to go into the business. Probably he has a very limited amount of capital available and there are few well-developed dairy herds near him. He has some cows on hand of mixed breeding with more or less beef blood. A man in this situation should begin milking all cows on hand as they freshen, taking care to have them in good flesh at calving time and making certain that a good ration is fed after freshening. This is giving the cows a chance to make good. The keeping of milk records should begin with each cow as she freshens. Probably half or more of the cows will prove to be such low producers, even when given a chance, that they will not return a profit. These should be sold as soon as conditions are favorable. The keeping of milk and fat records of each cow in the herd should be continued regularly from year to year.

A pure-bred bull from a family of heavy-milking cows should be purchased as soon as it is decided to develop a dairy herd. The heifers by this bull should be raised to replace the older cows that are discarded. If the herd has not been tuberculin-tested it should be tested and started on the way towards an accredited herd.

A somewhat modified plan for a person under the condition outlined would be to dispose of the stock on hand, if they are not what is wanted, and buy a bunch of bred heifers of the breed chosen. The other details of management remain the same. By starting in this manner with a bunch of well-bred grade females, the time required for getting a start is reduced three or four years. The investment is greater and the owner has to learn the business of feeding and management more quickly, since he will presumably have some good producing cows to deal with almost at once. There is always the danger of introducing tuberculosis or contagious abortion.

Another factor which may decide the practicability of this plan is the possibility of getting readily in the locality the animals wanted. If animals of the breed chosen are numerous locally, making purchase easy, the plan of starting with good grade heifers is to be recommended. On the other hand, if no cows of the breed wanted are available locally, it is generally impracticable for the farmer to purchase the animal needed from a distance. Under these conditions it is comparatively easy to buy and ship a bull, and for this reason the plan of improvement would be mainly one of using pure-bred bulls and culling out the unprofitable cows.

As a rule it is wise to purchase as few animals as possible and depend mainly upon raising those needed. Not only is there a constant danger of disease when animals are purchased; but when an inexperienced man goes to a distant locality to buy stock he often comes home with a group anything but desirable. As a rule the cows offered for sale are the culls, and if really good animals are offered the prices are proportionately high. To get a herd of good milkers together by purchase is possible but difficult and expensive. As a rule where all cows are purchased and none bred the average for the herd is decidedly lower and shows no indication of improvement from year to year.

When buying foundation animals for a grade herd the best buy usually is bred heifers. With animals of this age the type or appearance offers but a limited basis for judging their probable value. About all that can be done is to observe that the animals in question show by their breed characteristics an indication of having a liberal amount of improved blood and that they are well developed for their age and in a good thrifty condition. Possibly the most important point to take into account is the quality of the herd from which they come and especially their sire.

Often a beginner starts out with the idea of buying only cows with milk records. He soon finds it is impracticable to follow this plan, as it is difficult to locate such animals for sale, and when they are found the price is high. It is just as well to take the same amount of capital and buy more bred heifers. Some of them will prove unsatisfactory and it will be necessary to cull them out, but some extra good ones may also be found.

In recent years selling agents located in the districts where whole milk is sold to cheese factories or condenseries, making the raising of calves expensive, have found a business of considerable proportion in shipping heifer calves. The calves are shipped at the age of about two weeks and are generally guaranteed to be sired by pure-bred bulls. Farmers needing to add to their herds for the future, especially in cream selling districts where skim milk is available, find it profitable to buy calves under these conditions. It has been demonstrated that some danger of infection with tuberculosis exists even when calves leave an infected farm by the age of two weeks.

Guarding Against Disease. The problem of keeping a herd free from tuberculosis and contagious abortion is always a difficult problem. To the beginner it is a particularly important problem since these diseases, once introduced, are difficult to eradicate. If a herd is started with clean animals, and additions to the herd by purchase are kept to the minimum, it may be possible to maintain a healthy herd for years. Once a herd is free from tuberculosis, it is wise to practically limit the purchase of animals to the necessary bulls. Many breeders have learned by bitter experience that if the practice of adding to the herd from time to time by purchase is followed, sooner or later disease will gain a foothold, even though every possible precaution has been taken.

Tuberculosis. Tuberculosis is discussed later, so that it is the purpose here to consider only the question of starting and maintaining a herd free from this serious disease. Tuberculosis does not develop spontaneously. It spreads only by the transmission by an infected animal of the bacteria which causes it. An animal may have a bad case without showing any outside symptoms whatever. The placing of such an animal in a healthy herd may result in the greater part of the herd contracting the disease within a few months. Fortunately, we have in the substance known as tuberculin an agent that is fairly reliable in showing the presence of the disease even if it is present in the smallest degree only. When animals are bought, especially to start a herd with, every animal should be given the tuberculin test by a competent veterinarian. If possible the test should be under the supervision of the State Veterinarian, the Live Stock Sanitary Board, or such official as may have the local responsibility.

Unfortunately, when the animal passes the test successfully the danger is not always eliminated. When the disease has been very recently contracted, it may still be in the incubation stage and the animal will not show reaction at the time; but when tested a few months later he may react. Again, a cow in the advanced stages of the disease may also show no reaction to the test. These facts should be understood and kept in mind.

When buying from a herd in which tuberculosis is present at the time, or has recently been present, there is danger that animals showing no indication of the disease by the test may recently have contracted it and will react later. The most dangerous source of infection is the advanced case that does not react. A case of this kind may be spreading the infection among the herd entirely unsuspected by the owner. A cow in such condition is known as a "spreader."

When purchasing cattle, the important thing is to avoid both the recently infected animal and spreader, either of which may escape detection by the test. One means commonly recommended at present for locating an animal recently infected is by means of a retest. In recent years a condition of many sales, both public and private, is one allowing a retest in 60 or 90 days. Meanwhile the animal is to be kept isolated on the premises of the purchaser until the retest is made.

The retest, however, may not disclose the advanced case. In fact, no entirely satisfactory plan can be advanced to insure the elimination of such animals. The best recommendation is to require not only that the animals purchased pass the test successfully, but that they come from a herd in which there have been no reactions for several years—the longer the better. This does not entirely insure the exclusion of infection, but it will assist.

A cow in the advanced stages of the disease, and acting as a spreader, sometimes shows by her physical condition that something is wrong. While it should be understood that all spreaders do not show what they are by their physical condition—neither are all unthrifty animals infected with tuberculosis—still it is wise to be on the safe side and to reject from the herd any animal that becomes emaciated or shows a decidedly unthrifty appearance which cannot be overcome by good feed.

Abortion. This insidious disease ranks next to tuberculosis in importance to the dairy cattle industry. In fact, from a purely financial standpoint the loss is even greater. This disease is especially widespread, so much so that some authorities have made the sweeping statement that no herd of any size is permanently free from it. It seems safe at least that in practically every herd where animals are added frequently by purchase this infection is present in either active or dormant state.

While there are tests which are of some value in locating the animals carrying the infection, these tests can be conducted only in a well equipped laboratory; and, furthermore, the results are at the best uncertain and are of but little value as an aid in selecting a clean herd.

It is a well known characteristic of the disease to go in waves in a herd. For a period, usually a few months, it is very active, at times half the cows losing their calves; then it gradually recedes until for from two to four years the herd may seem practically free from abortion. While in this stage the owner often ascribes to accidents the few cases which occur. However, a cow very seldom, if ever, aborts from accidents, and so long as any cases of abortion occur the presence of the disease is probable. After a dormant period the disease flares up again as before—to be again followed in a few months by a dormant period. The importance of understanding these facts is to avoid over-confidence in assuming that because very few or no abortions have occurred for a number of months that the disease is gone. If it was once dormant, it is probably merely dormant again, only to break out later with increased virulence.

The indications are that the open heifer seldom carries the infection. If her first calf is aborted she probably became infected during the gestation period. This suggests that the danger of introducing the germ of the disease with purchased animals is reduced if heifer calves or unbred heifers are introduced rather than older animals. Further than this, about all that can be done with the limits of our present knowledge is to make careful inquiry regarding the health of the herd from which it is desired to purchase stock and to avoid the disease so far as practicable.

CHAPTER XII

SELECTION OF THE INDIVIDUAL COW

Necessity for Selection. Breeds are of great value as a means of preserving and transmitting qualities which have already been developed, and it is highly important to select a breed adapted to the purpose for which it is to be used. However, the selection of the individual cow within the breed is of even more importance as effecting the economic production of milk.

The highly developed dairy cow of today is, to a large extent artificial. It is safe to assume that the wild cow produced only milk enough to support the calf for a few weeks until it could subsist on other food. There was probably little difference in the amount of milk produced by different individuals at this time, and the milking characteristic was undoubtedly transmitted quite uniformly.

After cattle were in a state of domestication and the milk became an important article of human food, some attention began to be paid to developing the milking functions. Through natural variations, certain animals showed more highly developed milk-producing functions than others, and by using these animals for breeding purposes and stimulating the mammary glands by better feed and regular milking, a change was gradually made in the amount of milk secreted, and probably to some extent in the quality as well. While the wild cow possibly produced from one to two thousand pounds of milk in a year, a good dairy cow of today may produce more than this in a single month.

It is a well-known fact, and one easy to understand, that when any characteristic or function has been developed to a higher degree in a breed of animals than existed originally, the acquired characteristics may not be transmitted uniformly.

There is a constant tendency for the characteristic of some of the ancestors to appear. The more highly developed the animal is the more difficult, as a rule, is the retention of the acquired characteristics. This explains why there is such a wide variation in the capacity of individual cows to produce milk. Although wild cows presumably varied but little in the milk produced, it is not uncommon under present conditions for one cow to produce four or five or more times as much as another individual of the same breed kept under similar conditions in the same herd. These individual variations must be expected, and the higher the development of the dairy cow is carried the more difficult will it be to maintain this high production.

It is only within recent years that the full significance of individual variation has been understood by those who are engaged in dairy farming. One of the weakest points in the system of dairy farming as carried on at the present time is the failure on the part of a large number to appreciate the importance of this factor of individual selection, or, if it is appreciated, a failure to give this subject the attention and time which its importance justifies. Even when cows are milked regularly and the selling of dairy products is a regular business, the yearly butter production seldom exceeds 250 pounds per cow except in the hands of the special dairyman; and even among those who are making the sale of dairy products their principal source of income, the average production is comparatively low.

Variation in Production by Individuals. Credit for first calling attention to the great importance of the selection of the individual cow is due the Illinois Experiment Station.[1] Beginning in 1902, eighteen herds numbering 221 cows were tested through complete milking periods. A summary of the results is given in Table 12. The average milk production was 5,617 pounds and the fat production 227 pounds. The best herd averaged 350 pounds, the poorest 142 pounds, of butter fat per cow. The best ten cows averaged 389 pounds, the poorest ten 142 pounds, of butter fat per cow for the year. Herds which had been graded up by the use of a pure-bred sire produced 85 pounds of butter fat more per cow than did those in which no grading had been done. These herds were in the hands of men who were making the production of milk their principal business. As a result of the investigation it was concluded that at least one-third of the cows in ordinary herds which were being used for milk production in that state were unprofitable, and that on nearly every dairy farm a few cows were kept at an excellent profit, some at a small profit and some at an actual loss.

---

[1] Circular 102, Illinois Experiment Station (1906).

TABLE 12. PRODUCTION OF AVERAGE, BEST, AND POOREST COW, IN TWENTY-FOUR ILLINOIS HERDS

HERD	NO. COWS IN HERD	LBS. MILK			PER CENT FAT			LBS. BUTTER FAT		
		Average	Best	Poorest	Average	Best	Poorest	Average	Best	Poorest
1	11	5753	6099	4391	4.54	5.17	3.91	262	315	172
2	8	7376	8739	4928	3.19	3.81	3.92	268	333	193
3	5	8057	9454	6719	3.42	3.40	3.27	276	324	221
4	11	6220	7445	4091	3.89	4.82	3.83	242	359	157
6	20	7873	9067	5796	3.62	4.41	3.65	285	399	212
7	10	4525	5507	3412	3.76	4.70	3.78	170	264	129
8	10	4486	6647	2691	4.29	3.09	3.61	193	263	97
10	13	5431	7291	3847	4.18	4.31	4.38	227	315	168
11	9	5969	6531	5552	3.43	3.78	3.01	205	247	168
12	13	4504	6429	2090	3.89	3.80	4.83	175	248	101
15	12	5128	6289	3491	4.03	4.74	3.01	207	299	135
16	9	4608	5293	3752	3.98	4.49	3.99	184	238	150
17	7	4355	6115	3710	3.96	3.31	3.33	173	203	124
19	19	5410	6413	4530	4.11	4.57	3.49	243	293	158
20	15	6106	7530	2980	3.84	3.93	4.56	235	296	136
21	15	5971	8882	4025	4.06	3.75	3.55	243	333	143
23	25	3314	4337	1846	4.28	4.96	4.24	142	216	78
24	9	5921	6911	3478	5.91	6.91	4.64	350	477	161
	221	5616	6994	3962	4.03	4.55	3.83	226	301	150

A large amount of data has been accumulated since the pioneer work reported in Table 12 was published by the Illinois Experiment Station which corroborate these early conclusions. An especially valuable study of the question made in the Southern States[1] is reported in Table 13. These data show the same wide variation in the cost of production by individual cows as that found in the investigations previously noted. In this case the best cow produced butter at a cost of 13.4 cents per pound as compared with 37.1 for the least profitable. The best cow consumed feed worth $3 for each $1 expended for the poorest, but at the same time she gave a return of $8.30 for each $1 by the inferior animal.

TABLE 13. RESULTS OF TWELVE MONTHS' RECORD FOR 719 COWS IN THE SOUTHERN STATES

ITEMS	AVERAGE OF 719 COWS	BEST COW	POOREST COW	AVERAGE OF BEST 10 COWS	AVERAGE OF POOREST 10 COWS	AVERAGE OF BEST 30 COWS	AVERAGE OF POOREST 30 COWS
Milk produced, pounds	4299.40	8325.50	1125.00	8681.90	1577.60	7326.00	2099.60
Butter fat produced, pounds	216.84	538.79	64.12	459.00	77.21	391.75	100.70
Value fat at 28 cents	$60.71	$150.86	$17.95	$128.52	$21.62	$109.69	$28.20
Value skim milk at 20 cents a hundredweight	8.17	15.57	2.12	16.45	3.00	13.87	4.00
Total value of products	68.88	166.43	20.07	144.97	24.62	123.56	32.20
Cost of feed per cow	36.27	72.03	23.80	65.73	24.63	54.83	27.36
Profit per cow	32.61	94.40	–3.73	79.24	–0.01	68.73	4.84
Cost of producing 1 lb. butter fat, in cents	16.70	13.40	37.10	14.30	31.90	14.00	27.20
Returns for each $1 invested in feed	$1.90	$2.31	$0.84	$2.20	$1.00	$2.25	$1.18
Profit on each $1 invested in feed	0.90	1.31	–0.16	1.20	0.00	1.25	0.18

This table shows that the best thirty cows produced about three and one half times as much as the poorest thirty cows. The former gave a return of $2.25 for each dollar invested in feed to $1.18 for the latter. The best individual produced nearly eight times as much as the poorest.

---

[1] Twenty-fifth Annual Report, Bureau of Animal Industry, U. S. Dept. Agriculture, p. 67.

The following figures are taken from a report of a cow test association in Utah.

	Ten Highest	Ten Lowest
Average lbs. milk yield	8,779	4,584
Average per cent fat	3.98	3.77
Average lbs. fat yield	338	176

In this case the best ten cows produced almost as much as twenty cows like the poorest ten. It should be noted that the higher production was the result of more milk and that the test was practically the same.

Vast quantities of data could be assembled, all showing the same facts. The extremes in production indicated by the data given are not confined to any breed or geographical location. While in pure-bred or highly developed grade herds the proportion of inferior producers is less than in herds of more common breeding, still a certain proportion of unprofitable cows may be expected even in herds of this kind. It is no reflection upon a breeder to have such animals appear occasionally, but it is a reflection upon his judgment if he retains them in his herd.

The Economy of High Production. The amount of milk and fat produced bears a direct relation to the economy of production. This fact can be shown by any amount of data. That given in Table 13 is typical. The best thirty cows consumed feed worth $27.47 in excess of the poorest thirty animals, but produced 291 pounds more fat each.

The most abundant evidence on this point is furnished by the records of 120 coöperative cow-testing associations. The cows are grouped in classes according to the amount of fat produced in a year, and the gain shown for each group is the average net gain over cost of feed per cow. Groups with insignificant numbers have been omitted from this table.

TABLE 14. RELATION OF FAT PRODUCTION TO INCOME OVER COST OF FEED
A Summary of Cow Test Association Records[1]

NUMBER COWS	BUTTER FAT PRODUCED POUNDS	AVERAGE BUTTER FAT POUNDS	SELLING PRICE PER POUND	GAIN
43	26 to 76	58	$0.41	$13.88*
600	76 to 125	109	.44	12.48
2,305	126 to 175	154	.44	27.90
4,310	176 to 225	202	.44	42.45
4,748	226 to 275	251	.44	57.82
3,385	276 to 325	298	.44	73.34
1,635	326 to 375	347	.44	89.67
652	376 to 425	396	.44	105.07
214	426 to 475	446	.45	124.85
79	476 to 525	493	.43	135.30
27	526 to 575	543	.40	134.80

*Loss

It will be seen that 600 cows averaging 109 pounds of fat in a year earned only $12.48 each over the cost of feed; whereas 3,385 cows producing close to 300 pounds of fat showed earnings six times as large, and 214 which produced close to 450 pounds of fat each earned ten times as much as the first group.

The following table shows the results of a survey of the cost of milk production in Jefferson County, New York.[2]

TABLE 15. RELATION OF MILK PRODUCTION TO INCOME ABOVE FEED.
Jefferson County, New York

AVERAGE LBS. YEARLY MILK PRODUCTION	NUMBER COWS	PROFIT PER COW OVER FEED COSTS
5,000 or less	159	$6.04
5,001 to 7,000	360	16.69
7,001 to 9,000	214	27.21
9,001 to 11,000	84	39.39
Over 11,000	17	75.53

---

[1] McDowell, J. C., Bulletin 1069, U. S. Dept. Agr. (1922).
[2] Bulletin 357, Cornell University Experiment Station (1915).

This survey embraced 53 herds numbering 834 cows, the average production being 6,621 pounds milk and 241 pounds fat; 19 per cent of them caused their owners a loss of $11.18 each.

As a further illustration of the advantages of keeping good cows, the following figures are shown as the result of a study of milk production in three counties in New York State.[1]

TABLE 16. RELATION OF MILK YIELD TO NUTRIENTS REQUIRED

AVERAGE LBS. YEARLY MILK YIELD	NUMBER COWS IN GROUP	TOTAL DIGESTIBLE NUTRIENTS PER 100 LBS. OF MILK
5,000 or less	335	58.5
5,001 to 7,000	368	47.1
7,001 to 9,000	112	42.6
Over 9,000	32	40.0

As the production increased, the total digestible nutrients per hundred pounds of milk showed a decided decrease.

Extensive figures were gathered in Wisconsin some years ago during a dairy cow competition (see Table 17)[2]. The cows are listed in groups of thirty, according to production.

TABLE 17. RESULTS FROM THE WISCONSIN DAIRY COW COMPETITION

GROUPS OF 30 COWS	AVERAGE LBS. BUTTER FAT	VALUE OF PRODUCT	COST OF FEED	NET RETURN
1	673.9	$217.26	$102.71	$114.55
2	568.9	182.86	91.40	91.46
3	528.9	170.99	86.49	84.50
4	493.8	158.78	84.74	74.04
5	472.4	150.60	81.87	68.73
6	455.6	145.24	75.69	69.53
7	438.3	139.38	71.72	67.66
8	421.0	134.43	70.96	63.47
9	399.3	126.28	72.47	53.81
10	375.0	117.91	72.13	45.78
11	355.1	110.98	60.78	50.11
12	326.9	102.41	57.66	44.75
13	274.9	86.29	56.56	29.73

---

[1] Bulletin 364, Cornell University Experiment Station (1915).

[2] Research Bulletin 26, Wisconsin Experiment Station (1912).

A careful study of the cost of producing milk in four dairy farms located in Wisconsin, Michigan, Pennsylvania, and North Carolina brought out the same truth regarding the relation of the individual cow to the cost of production in the herd as a whole. Table 18 gives the results in tabular form.[1]

TABLE 18. RELATION OF PRODUCTION TO FEED COST AND INCOME RESULTS FROM WISCONSIN, MICHIGAN, PENNSYLVANIA, AND NORTH CAROLINA

Production of Milk per Cow Lbs.	No. Cows	Average Production Lbs.	Average per Cow per Year			Average per 100 Lbs. Milk	
			Feed Cost	Other Cost	Total Cost	Feed Cost	Total Cost
3,000 and under	16	2,349	$43.93	$39.97	$83.90	$1.87	$3.57
3,001 to 4,000	33	3,648	49.47	45.01	94.48	1.36	2.50
4,001 to 5,000	78	4,596	55.00	50.04	105.04	1.20	2.29
5,001 to 6,000	111	5,450	59.91	54.51	114.42	1.10	2.10
6,001 to 7,000	109	6,445	62.85	57.18	120.03	.93	1.86
7,001 to 8,000	60	7,513	70.38	64.04	134.42	.94	1.79
8,001 and over	36	9,049	80.45	73.20	153.65	.89	1.70

It will be noticed that as milk yield increases there is also an increase in the feed cost and in other cost items, but not in the same proportion. The decrease in cost of producing one hundred pounds of milk is much greater between the very poor cow and the cow of medium quality than it is between the medium cow and the good cow. Because of this fact the most rapid herd improvement will follow the elimination of the poorest cows.

A study of the yearly records of 18,014 cows kept by cow test associations is summed up by McDowell as follows: "As butter fat production increased from 100 to 400 pounds there was a regular increase of about $16 in income over cost of feed per cow for each 50 pounds of increase in production of butter fat.

"Cows having high average production of milk and butter fat averaged high in income above feed regardless of breed, age, weight, date of freshening, or geographical location. Cows having an average milk production of 3,250 pounds had an average income of $32.50 over cost of feed, while those having an average milk production of 13,250 pounds had an average income of $218.19 over cost of feed. The average production per cow in the latter group was about four times as great and the average income over cost of feed was nearly seven times as great as in the other group."

---

[1] Bulletin 501, U. S. Dept. Agr.

The general conclusion can be drawn from the data given that it costs from $5 to $30 more per year to feed a cow, depending upon the price of feeds, that will produce 300 to 400 pounds of fat, than it does to feed a cow producing from 100 to 200 pounds of fat.

These figures illustrate very closely the conditions as they exist in the average herds of cows that are kept for milking purposes. The farmer too often makes the mistake of thinking that a certain number of cows should give a certain amount of product, and that the sum received from his herd should be comparable with that received from another herd of the same size. The point is overlooked that it is not quantity, either of milk produced or number of animals kept, that determines the profit, but the income in excess of the cost of production. In any herd of 15 to 20 cows that has not been carefully culled, a greater total profit will be realized by retaining from one-half to two-thirds of the herd and disposing of the inferior ones. This is especially true of herds composed of common grade and dual-purpose animals.

One cow producing 300 pounds of fat in a year makes vastly more profit than do two cows producing 150 pounds each, although the total production is the same in each case. The reason can be easily understood when we consider the use which the animal makes of its feed. The first use to which the cow puts the feed given her, as is the case with any animal, is to maintain the body, which in this case is keeping up the machinery for milk production. The feed necessary for this purpose is called the ration of maintenance. With an ordinary cow producing 200 pounds of fat in a year, the ration of maintenance represents from 50 to 60 per cent of the feed she consumes; in the case of a better producing cow about from 40 to 50 per cent of her ration; while an extraordinary producing cow may not use over 35 per cent of her ration for this purpose. This may be looked upon as a fixed charge which has be to made in the case of every animal, and since in any, except especially good producing herds, at least half of the feed will be used for this purpose it is clear that keeping two cows to do the work of one is increasing the total amount of feed used by something like 25 per cent.

Cause of Individual Variation. In this chapter it has been the purpose to emphasize the selection of the cow from the standpoint of her milk producing capacity. The assumption has been in this discussion that the low production figures are due to a limited capacity of the cow to produce milk; in other words, that all have had a fair chance. As a matter of fact, low production under farm conditions is the result of poor feeding as frequently as of inferior animals. The figures used, however, in most cases are not comparisons between herds but within herds, and by this means the result of variation in feeding is largely eliminated.

Limiting the discussion from this point on to the cause of the variation in capacity of the cow to produce leads to a consideration of milk secretion.

The cow that is a superior milk producer for her breed has received something by inheritance differing in degree from that inherited by the inferior milk producer. As pointed out in other connections, without this internal factor, this stimulation from the inside, the best of feed and care will not yield results. Just what this internal factor may be is a physiological question too difficult and involved to be discussed here except in a brief statement. According to physiologists the udder glands which secrete milk are stimulated into activity as the result of the secretion of other glands, belonging to that group known as ductless glands. The stimulating substance is secreted by some part of the reproductive organs or elsewhere in the body and is carried through the blood. This substance, known as a hormone, stimulates the udder gland to produce milk. The amount of this substance that a certain animal secretes depends upon the development and vigor of the gland by which it is manufactured. A good dairy cow is one that has inherited the power to form a large amount of this substance, while an inferior animal is one with a weak stimulation to produce milk. From this viewpoint the selection of the cow is choosing the one that has a strong stimulation to produce milk.

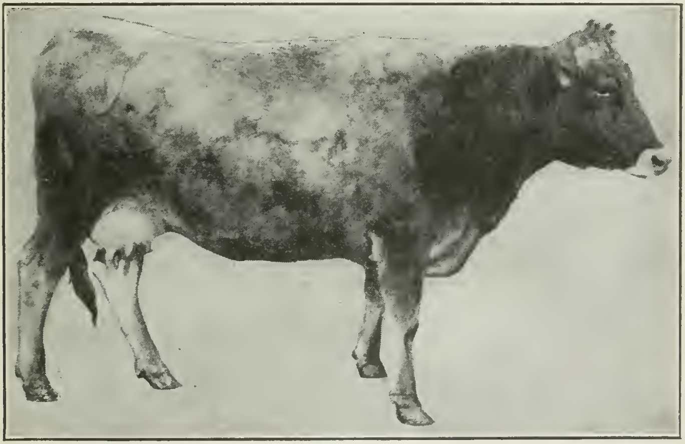


FIG. 26. Pure-bred Jersey cow referred to as No. 62. This cow had good ancestors, was healthy and vigorous but did not have the internal stimulation to give milk freely. Her best production was 169 pounds of fat in a year. She is inferior by inheritance and cannot be made a profitable cow.

An experiment made by the author illustrates how strong this stimulation to produce milk is with a highly developed dairy cow. A mature Jersey cow was fed a liberal ration while dry; she calved in more than moderate flesh. Her ration was then adjusted to supply only nutrients sufficient to support the body, leaving nothing for producing milk. She was compelled either to cease producing milk or to make it from the reserve on her body. This was continued for 30 days. At the end of this time she was producing only one pound of milk per day less than in the beginning, but was so weak she could hardly get up without assistance. During this time she lost 115 pounds in her weight and produced over 90 pounds of solids in the milk from her own body.

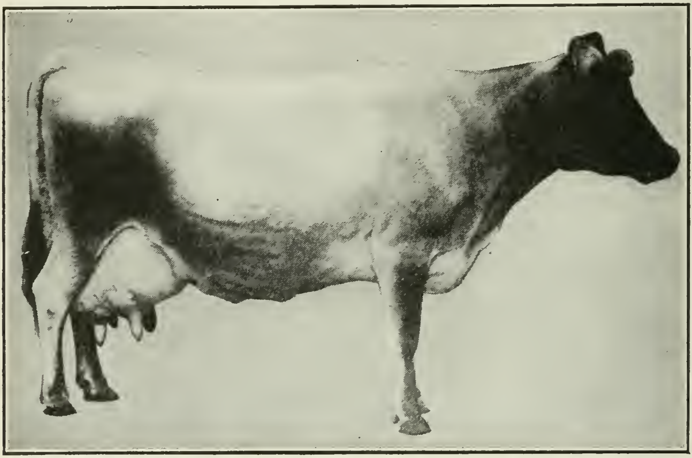


Fig. 27. Pure-bred Jersey cow No. 27, a half sister to No. 62 in Fig. 26. Unlike her sister she inherited a strong stimulation to use her feed for milk production. She produced 469 pounds of fat. Individual selection is necessary to insure a herd of uniformly high producers.

According to the view expressed, the high-producing cow secretes milk on account of the strong stimulation she has in her body. To replace these nutrients she has a keen appetite and consumes a large amount of food. The point is this, she consumes the heavy ration because she produces a large amount of milk. The consumption of the heavy ration is the result and not the cause of the heavy milk production, and likewise the form or shape of the animal is influenced to a degree. Her inherited stimulus to produce large quantities of milk demands that she consume ample feed, which tends to develop the organs of digestion. Similarly, the generous secretion of milk develops the mammary system. The result is the close approach to the ideal dairy form. This subject is further discussed in connection with feeding, to which it bears an important relation.

Reason for Economy of High Production. It seems entirely reasonable that a cow producing a large quantity of milk should be a more economical producer than one with a small capacity. However, careful thought is required to properly understand the reason. The assumption is often made that the good dairy cow in some way is able to get more out of feed than an inferior cow, but digestion trials do not bear out this view. The portion of a given ration that is digested and used is practically the same for all individuals, regardless of milk producing ability, age, or breed.

The real explanation as to the economy of production by the higher producer may be illustrated to advantage by reference to results obtained by the author in a study of this subject. The two cows used were registered Jerseys and daughters of the same sire. The striking difference in their milking ability attracted attention. The good producer is designated as No. 27 and her inferior half sister as No. 62. The cows were about the same age and were raised in the usual manner on a typical skim milk ration. During the first two years in milk under the same conditions and with equal opportunities the results were as follows:

	Average Lbs. Milk per Year	Average Lbs. Fat per Year
No. 27	5,863	308
No. 62	2,003	79

These striking results attracted attention and plans were made to find the explanation. The two cows were bred so that they calved one week apart, and they were then kept under the following conditions:

1. Complete record kept of amount and composition of feeds consumed.
2. Ration fed the two cows of the same composition at all times, the amount varied to suit the individual.
3. Cows kept at uniform weight.
4. Complete records made of milk produced and of its composition.
5. Cows kept farrow.
6. Digestion trial conducted when the cows were at their maximum production.
7. Cows kept on maintenance for four months at the end of the milking period to determine maintenance. Maintenance ration of same composition as that fed when producing milk to determine maintenance in terms of the ration fed.

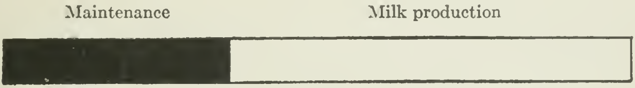
During the year, No. 27, the better cow, produced 8,522 pounds of milk and 469 pounds of fat, while No. 62, the inferior cow, produced only 3,188 pounds of milk and 169 pounds of fat, although (1) the maintenance requirement was practically the same for each, and (2) the coefficient of digestion was almost exactly the same.

Table 19 gives the feed consumed during the year, the amount of feed required for maintenance, and the amount available for milk production by the two cows.

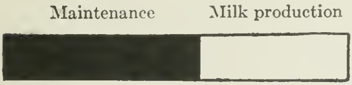
TABLE 19. FEED CONSUMED, MAINTENANCE REQUIREMENT, AND AMOUNT USED FOR MILK. COWS NOS. 27 AND 62

	LBS. GRAIN	LBS. HAY	LBS. SILAGE	LBS. GREEN FEED
No. 27				
Consumed during year in milk .	3,424	2,904	8,778	4,325
Maintenance for year	1,201	1,205	4,818	
Available for milk production .	2,223	1,699	3,960	4,325
No. 62				
Consumed during year in milk .	1,907	1,698	5,088	2,102
Maintenance for year	1,066	1,066	4,293	
Available for milk production .	841	632	795	2,102

It will be noted that the feed available for producing milk is much larger for No. 27 than for No. 62. During the year in which these rations were fed No. 27 produced 2.77 pounds of fat to each pound produced by No. 62. During the same period No. 27 had 2.64 pounds of feed available for milk production to each pound available by No. 62. This means that after the ration of maintenance was supplied practically the same amount of food was required by each for making a pound of fat. The real difference between the two cows was that with No. 62 the stimulation for secreting milk was limited to about one-third that possessed by No. 27. No. 27, due to this strong stimulation produced nearly three times as much milk as No. 62, and as a result required more feed. No. 27 was a more efficient milk-producing machine on account of greater capacity to use food above maintenance. The food she consumed was not used to any better advantage than that eaten by the inferior cow. No. 62 required 55.8 per cent of her ration for maintenance, and No. 27 only 35 per cent.



Cow 27. Record: 469 pounds fat.



Cow 62. Record: 169 pounds fat.

FIG. 28. This graph illustrates the use of feed by No. 27 and No. 62. The amount used for maintenance was about the same for both. In addition No. 27, on account of her greater internal stimulation to produce milk, used 2.6 times as much feed for milk production as No. 62. The higher producer uses more feed, but is the more economical because of the smaller overhead in the form of maintenance.

The problem is illustrated graphically by Fig. 28. From the farmer's standpoint No. 27 was a very profitable cow, while No. 62 did not pay for her feed. The difference between these two cows in regard to the use of food clearly was the amount used above that necessary to maintain themselves. This experiment shows that the main difference between profitable and unprofitable dairy cows is not to be found in the coefficient of digestion or in the food required for maintenance. A superior dairy cow is one with a large capacity for using food above that maintenance requirement and one that uses this available food for milk production.

Other overhead expenses. So far the discussion concerning the economy of high production has been limited to the question of feed costs. It should be kept in mind that the feed cost is approximately half the total expense of milk production. Table 18 supplies data on this point. The other expenses include labor, barn expense, taxes, depreciation in value, bull service, and veterinary fees and possibly others of minor value. These overhead expenses, like those of feed, increase somewhat as the level of production is raised but not at all in proportion. In Table 18 it will be noted that the other costs for cows producing 3,000 to 4,000 pounds yearly was $45.01 a year or $1.28 a hundred for the milk. For cows producing 7,000 to 8,000 the costs other than feed were $64.04 a year or 85 cents a hundred. The high-producing cow, as pointed out, uses more feed than the cow producing at a lower level; and the same is true for the overhead expenses other than feed. But the important point is that this increase is not in proportion to the increase in milk produced and the great economy of high production results from a combination of this saving in feed and in general overhead expenses.

CHAPTER XIII

SELECTION OF THE COW BY RECORDS

Methods of Selection. The selection of the individual cow has to be made either by judging the dairy qualities of the animal from her conformation, or from records of her milk and fat production. There is no doubt that in most cases the high-producing dairy cow shows what is generally recognized as the dairy type. Competent judges can readily select very good cows from inferior ones by observing the extent to which they approach the recognized dairy type. However, dairy type alone cannot be depended upon as a means of selecting the best dairy animals from among a number of good ones. As a rule, it is possible to select cows that are capable of producing from 300 to 350 pounds of fat in a year from those that will produce one-half that amount; but it is practically impossible to select a cow capable of producing 400 to 500 pounds of fat from one producing 300 pounds of fat. Often those persons most familiar with the subject, however, will make decided errors in selecting animals by this means.

One of the special difficulties in selecting animals by type is that the conditions under which the selection is made are often very unfavorable. In the show ring the cows exhibited in the mature classes are nearly always in milk, and all are well fed and in good physical condition. On the other hand when one farmer is buying from another the conditions are far less favorable for comparing the animals. Some are fresh, others dry or nearly so. Some may be in good condition; others, on account of poor feeding, thin in flesh and unthrifty in appearance. It is questionable if many judges of dairy cattle would recognize as superior animals many of the great record cows of the various breeds if they were dry and in a herd of any considerable size, the majority of which were in poor condition.

Selection by type, however, has its value, even in dealing with grade cows kept for commercial production alone, since it is generally the only practicable basis for buying such animals. Records of production are available for only a limited number of cows, and those which have demonstrated their worth are not generally for sale. In case an animal is to be purchased for which no records of production have been kept, the buyer must depend mainly upon the evidences of dairy characteristics as shown by the animal, and it will be well to depend upon these rather than to attempt to select by weighing and testing the milk for a single milking, or for an entire day even. As a rule, in such a case the conformation of the animals should be depended upon as an indication of dairy quality rather than statements regarding the production of the animal, unless such statements are based upon actual weights and tests taken.

Selection by Records. When cows are to be purchased it is generally necessary, as suggested, to depend to some extent upon the indications of dairy qualities as shown by the type of the animal. In the management of a herd the conditions are different, and there is no reason for basing upon their dairy type the selection of the individuals to be retained in the herd. The only satisfactory way to select the profitable from the unprofitable in a herd of dairy cows is by keeping records of the amount of milk produced and then testing for butter fat at regular intervals. There is no excuse for not keeping records in order that the unprofitable cows may be detected and rejected from the herd as soon as possible.

The records to be taken should include the total milk production based upon the weighing of each milking, and the fat production calculated from the average fat percentage in the milk and the total milk. When the milk is sold by weight alone the producer is interested mainly in the milk yield, but it is wise even under these conditions to keep the fat records as well. In keeping records, or in making use of the records in buying or selling cattle, care must be taken to give proper weight to milk yield and to the fat content. As shown by the next paragraph it is a serious mistake to judge an animal by either of these alone.

Overrating the Importance of Rich Milk. A common mistake in the judging of the value of cows is that of attaching undue importance to the richness of the milk. The cow that gives the richest milk does not necessarily produce the largest quantity and is not necessarily any better than, or even as profitable as the cow yielding milk with a smaller per cent of fat. It is the total fat production rather than the fat percentage that counts. The fallacy of depending upon the per cent of fat in the milk as an index of the value of an animal is especially dangerous when animals of different breeds are involved. The figures given below are the average of the records of a group of each breed represented, made under the supervision of the author.

	Lbs. Milk	Per Cent Fat	Lbs. Fat
Holstein	10,911	3.5	382
Guernsey	6,971	4.96	346
Jersey	6,749	5.01	338

It is clear from these figures that neither the milk nor the fat yield alone offers a fair basis to judge between the breeds. Judging by the fat percentage alone, the Jersey and Guernsey are far superior; while if the milk yield is made the basis of judgment, the Holstein is far in the lead. The same condition exists within the breed. A herd of any breed should not be culled upon the basis of the test alone, nor should either high or low test be overemphasized when buying or selling without taking the milk yield into account as well.

A study of the subject reveals that within a breed there is no apparent relation between the milk yield and the richness of the milk. This truth is somewhat contrary to popular opinion, which is that a high milk production goes with a low test and low milk production with a high test. Figures in Table 20 are assembled from records of a herd under the author's supervision.

TABLE 20. RELATION OF PER CENT OF FAT TO MILK YIELD AND TO TOTAL FAT PRODUCTION

BREED	HERD NO.	LBS. MILK YIELD PER YEAR	LBS. TOTAL FAT YIELD	AVERAGE PER CENT FAT
Jersey	1	13,895	681	4.90
Jersey	16	12,729	634	4.98
Jersey	124	13,322	625	4.69
Jersey	62	3,188	169	5.31
Jersey	5	2,797	176	6.20
Jersey	45	2,849	126	4.60
Holstein	204	18,405	618	3.41
Holstein	211	17,692	519	2.93
Holstein	214	5,436	212	3.92
Holstein	205	6,387	208	3.20
Guernsey	502	13,878	606	4.37
Guernsey	G–4	3,388	146	4.30
Guernsey	G–6	2,307	134	5.80
Guernsey	517	12,188	622	5.10

These figures show that there is little if any relation between the yield of milk and the test. A high milk yield may be accompanied by either a low, a medium, or a high fat content; and the same may be said of a low milk yield. The test of the milk bears little relation to the total fat yield. There is, however, a very close relation within the breed between the milk yield and the fat yield. The striking fact brought out by this table is that the milk yield varies far more widely than does the fat percentage.

In the figures given, one Jersey produced more than five times as much milk as another; and this result is not unusual with any breed. It might be possible to find one cow that would show an average fat content one half higher than another in the same breed; but even such extremes are exceptional. In a herd where different breeds are represented, the variation in fat percentage may be somewhat wider.

The Importance of the Milk Yield. The foregoing discussion shows that the variation between individual cows is from three to five times as great in milk yield as in fat percentage, and that the milk yield bears a very close relation to the total fat production. These facts make it clear that the most important part of records is the weights of the milk. In starting to keep records provision should always be made first for keeping the weights. It is at least three times as important to weigh the milk as to test it, although both should be done. The man who attempts to cull his herd on the basis of a few butter fat tests made from the milk of each cow will certainly do his animals injustice in many cases. In fact, culling on such a basis is worse than useless. The advice often given "to go after your cows with a Babcock test" is not sound. The test is needed, but the first and most important thing is to keep the record of milk produced. This should be accompanied by systematic testing for fat with the Babcock test.

In communities where milk is sold to factories on the butter fat basis, certain herds are often considered the best in the community simply because the per cent of fat from these herds is the highest; but this should not be taken as evidence that they are the most profitable herds.

There are three things that should be known in order that the relative profits may be known from the individual animals. These are: the amount of milk produced, the per cent of fat, and the cost of feed consumed. In regard to recording the feed cost of each animal, the view of the author is that it is not practicable on the farm, because of the time required. It is wise, however, to keep sufficient records to determine if the herd as a whole is profitable. It is well established that within the herd the profits are in direct proportion to the production of the animals.

Keeping Milk Records

Various plans for keeping records have been tried. One suggested some years ago was to weigh and test the milk of each cow for a period of seven days once each three months. From the figures obtained the yield was calculated for three months, of which the test period was the middle week. This plan was better than none, but it has little to recommend it in comparison with others, and it is seldom followed at present.

Testing at Monthly Intervals. Another plan which is used to a considerable extent consists in weighing the milk for a period of from one to three days, once a month, and testing a sample representing the same interval for butter fat. In carrying out this method, the best arrangement is to weigh the milk from each individual cow for three days about the middle of the month. A composite or average sample of the milk is also taken during the same time, which is tested for per cent of fat. The average milk and fat produced for the three days is taken as the average for that month. This should be carried out regularly each month during the year. The total production of each cow as shown by such tests is close enough to the actual for all practical purposes. One disadvantage of the plan is that the milkers often forget to take samples at the proper time. It is found to be much easier to get the records when each milking is weighed. Another serious disadvantage is that daily milk records are not at hand to serve as guides for feeding and for checking up the efficiency of milkers. Essentially this plan is followed by many members of cow-test associations who depend entirely upon the records taken for one day each month by the tester. Others follow the better plan of weighing the milk of each cow regularly, depending for the fat test upon the sample for one day each month taken by the tester.

The Most Satisfactory Plan. Experience has shown that the most satisfactory plan by all means is to weigh and record every milking of each individual animal. The fat test may be made from a composite sample representing three days in the middle of the month. To the dairyman who has never followed such a plan, this appears a time-consuming task. When it is carried out under proper arrangements, however, the additional time required to weigh and record each milking is found to be less than that usually anticipated; and the testimony of those who follow the practice is that the returns are perhaps greater than for the same amount of time devoted to any other part of the farm activities.

The first reason for keeping records is that it makes it possible to know definitely which cows are profitable and to dispose of the inferior animals. Experience has shown that without such records the individuals in a herd are often greatly misjudged. In many cases the individual which the owner considered the best is found by actual records to be far below others which were not looked upon with any special favor. Without records certain cows become favorites of the milkers, some on account of their disposition, others because they milk easily. These favorites are usually held to be the best cows by the milker, but often the records tell a different story. It is conceded by all who have had experience in keeping records that the judgment of the milker concerning the relative production of the cows in the herd is really worth but little.

The second important reason for keeping daily records of milk produced by each animal is that it makes possible the proper feeding of the individual cows. All skilled feeders recognize that cows in milk should be fed grain in proportion to their milk production. Unless there is a record of the daily milk production available no satisfactory basis is at hand by which to regulate the amount of feed supplied. Even when the milker also does the feeding, unless he also keeps daily milk records he will have a very indefinite idea of how much milk the cow is producing and how much grain she should receive. In large herds where the same man does not do the milking and the feeding, the difficulty is even greater in getting the individuals fed as they should be if no records of milk production are available. In a large herd with milk records at hand the person responsible for the herd can, by looking over the milk sheets at intervals of a week, estimate closely the amount each animal should be fed. A figure placed over the stall serves as directions for the feeder.

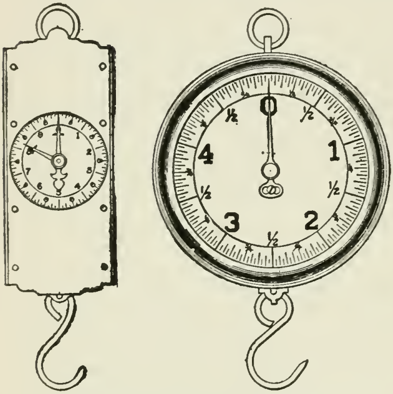


Fig. 29. Scales for weighing milk

The scales should be graduated to tenths of a pound and have an extra hand which can be set to tare the bucket.

The third advantage in having daily records is the opportunity it affords the herdsman to detect sickness in a particular animal before it would otherwise be observed. If there is a noticeable decline in the amount of milk produced, with no apparent cause, it is certain the animal is not in the right condition and will probably show a more marked case of sickness very soon, if not properly treated. When such a sudden decline occurs, the herdsman, by adjusting the ration and giving the cow some special attention, will be able in many cases to prevent the development of what might otherwise be a serious case of sickness.

A fourth reason for weighing and recording each milking regularly is the chance it gives to judge of the work of different milkers. It is a well-known fact that some milkers are able to secure much more milk from the same cows than are others. The difference may be as much as 25 per cent, or even more. Especially where there are several milkers in the same herd, it is impossible to form a fair estimate of their work unless each man milks the same animals regularly, and each lot of milk is weighed and recorded.

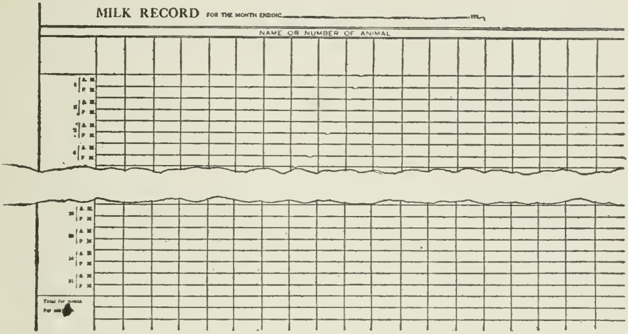
A fifth and a very important purpose in keeping records is the interest the practice adds to a task that is at best more or less monotonous. When each milking is recorded, the milkers will observe the variations from day to day and find many things of interest in tracing the cause. A friendly spirit of competition is often developed which also leads to more interest in the work and, consequently, better results.

Method of Taking and Testing Samples. Where many samples for testing are to be taken, the most convenient and accurate method is with a sampling tube, which can be purchased from a dairy supply company. In taking a sample with this apparatus the sampler, which is a brass or copper tube, is lowered in the pail of milk and then closed. The milk remaining in the tube is placed in a pint glass jar bearing the name or number of the cow. These jars must be kept covered tightly to prevent evaporation. If a sampling tube is not at hand, a satisfactory sample may be prepared by taking equal quantities of the milk from each milking with a very small dipper after thoroughly mixing them by pouring from one pail to another. A screw-top jar, properly labeled, should be provided for each cow to be tested. Some preservative is used to prevent the souring of the milk before the time for testing. For this purpose formalin, which may be purchased from any drug store, is one of the best agents. Ten drops of this substance will be sufficient to preserve half a pint of milk for several days. A small amount of corrosive sublimate (bichloride of mercury) serves the same purpose. This substance is a strong poison, and for this reason milk containing it must be handled very carefully. A quantity as large as a grain of wheat is ample to preserve a sample for testing. If corrosive sublimate is used it is wise to use it in the form of prepared tablets containing a coloring matter, or to add some common dye to prevent the milk from being used for food by mistake. The samples when complete are to be tested by the Babcock test.

Calculating the Fat Yield. The reading of the Babcock test is in terms of butter fat percentage or pounds of pure fat per 100 pounds of milk. The total yield of milk multiplied by the per cent of fat gives the total fat yield. If the cream from this milk should be separated and churned into butter, a yield of butter would be obtained in excess of the butter fat. This results from the incorporation of some curd, considerable water, and a small amount of salt with the fat, the mixture being ordinary butter. If proper methods are followed, the yield of butter will exceed that of the fat in the milk by about one-sixth. This excess of butter over butter fat is known as "over run." The over run in a skillfully operated creamery should be 20 to 22 per cent, based upon the fat as found by the Babcock test applied to the cream. The over run is higher in this case because the loss in the skim milk is not included and the skilled creamery operator is able to control the composition of the butter very closely.

Form of Keeping Record. In keeping records of the production of individual animals one of the first essentials is to arrange a system to be followed. In many cases those who have undertaken to keep records of milk and fat production have not carried out their intentions long, for the reason that they started without any carefully prepared plan and with no convenient way to keep their records.

Fig. 30 shows a portion of a sheet to be used in the barn for recording the milkings. Some use sheets with space for seven days only, although the most common plan is to have the sheet arranged to cover an entire month. The milk scales used should be graduated to tenths of a pound rather than in ounces as this saves considerable time in adding the sheets. The scales should be hung at a point convenient for the milkers.


MILK RECORD FOR THE MONTH ENDING ________ 191_

NAME OR NUMBER OF ANIMAL

1 A.M.
P.M.
2 A.M.
P.M.
3 A.M.
P.M.
4 A.M.
P.M.
28 A.M.
P.M.
29 A.M.
P.M.
30 A.M.
P.M.
31 A.M.
P.M.
Total for month

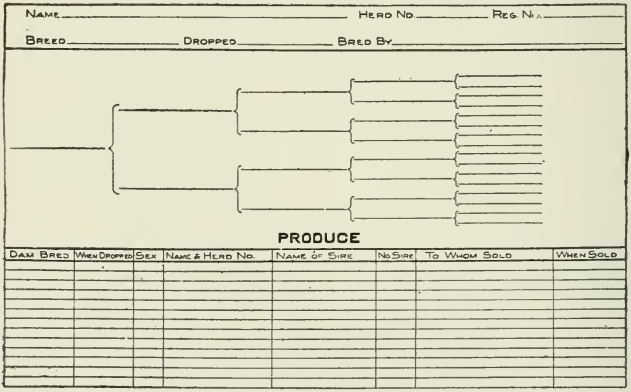
FIG. 30. Milk sheet—a form for keeping daily milk records. Blanks arranged to keep the records for a month are generally preferred. Provision should be made to keep the sheets clean.

The milk sheet is best placed on the wall besides the scales. Without some means of protection the milk sheet becomes badly soiled before the records are completed and it is ready to be removed. Various forms of holders have been designed for this purpose. Plans for such devices may be obtained in some cases from the state experiment station.

Adding Records. Part of the value of keeping records is realized from day to day but their full value comes only from having proper totals for each month and, finally, for the year. Adding up the milk sheets is a tedious task if it is done without the aid of a modern adding machine. Some farmers find it possible to make use of adding machines in local banks or to employ some one having the use of such a machine.

Where no assistance of this kind is available it is suggested that the figures for three days be taken and the average of these be used as the average daily yield for the month. The days selected should be the 5th, 15th, and 25th. The total for these three days is easily found. This total divided by three gives the average daily yield for the month which is found to be very close to the actual yield, inasmuch as the three days selected are distributed through the month.

A Permanent Record. It is customary to think in terms of calendar months, and in keeping records the best plan to follow is that of using the calendar month as the unit. After the totals by months are available there is seldom occasion to make use of the daily records. It is desirable then to record these totals in a permanent form in a book which will be kept in the office for reference. The form in which these records are kept is very important in determining their value to the cattle owner. Books designed for this purpose are on the market or suitable forms may be made in a few hours by ruling the pages of a large note book having good quality of paper.



NAME ____ HERD NO. ____ REG. NO. ____

BREED ____ DROPPED ____ BRED BY ____

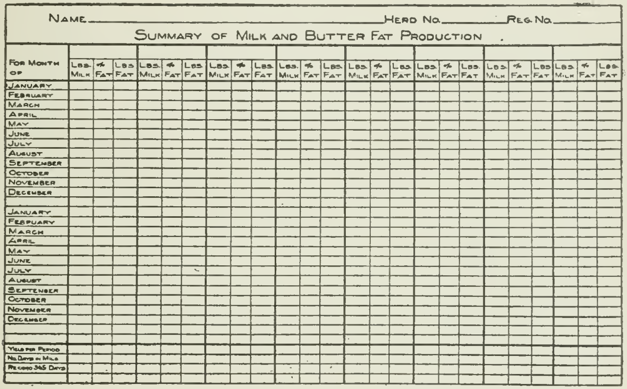
PRODUCE

DAM BRED	WHEN DROPPED	SEX	NAME & HERD NO.	NAME OF SIRE	NO. SIRE	TO WHOM SOLD	WHEN SOLD

Fig. 31. Form for a permanent record

Suitable blank forms are essential for record keeping. This form is especially desirable for a pure-bred herd. It is designed for use in a loose-leaf book. Fig. 32 is the other side of the leaf.

A form used for many years by the author, and which meets the requirements exceptionally well, is illustrated in Figs. 31 and 32. This form of record is especially valuable for the pure-bred herd. The illustration shows the sheets printed and perforated for use in a loose-leaf book. The pedigree and record of progeny appear on one side of the sheet and the production record by lactation periods on the reverse side. Two holders are needed when the loose-leaf system is used. In one is kept the leaves bearing the records of the cows in the herd; in the other holder are placed the leaves for the animals which are no longer in the herd.



NAME ______________________ HERD NO. ________ REG. NO. ________

SUMMARY OF MILK AND BUTTER FAT PRODUCTION

For Month of	Lbs. Milk	% Fat	Lbs. Fat	Lbs. Milk	% Fat	Lbs. Fat	Lbs. Milk	% Fat	Lbs. Fat	Lbs. Milk	% Fat	Lbs. Fat	Lbs. Milk	% Fat	Lbs. Fat	Lbs. Milk	% Fat	Lbs. Fat	Lbs. Milk	% Fat	Lbs. Fat	Lbs. Milk	% Fat	Lbs. Fat
January																								
February																								
March																								
April																								
May																								
June																								
July																								
August																								
September																								
October																								
November																								
December																								
January																								
February																								
March																								
April																								
May																								
June																								
July																								
August																								
September																								
October																								
November																								
December																								
Yield per Period																								
No. Days in Milk																								
Record 365 Days																								

FIG. 32. Form for keeping permanent milk and fat records

A page with this ruling has space for recording the records of a cow for eight years. Only one lactation period is placed in a column. If the cow calves in June the total for that month is placed opposite the first June in the list of months.

It will be noted that the months of the year are arranged in order, 24 months being allowed for in each column. In entering a year's record of a cow, the first month's record is entered opposite that month the first time it appears, beginning at the top of the column. It leaves room in every case for at least 13 months' record. Each new lactation period should be begun in a new column.

At the end of the milking period the record is added and the total inserted. In finding the average per cent of fat, the total fat yield should be divided by the total milk to give the true average per cent of fat. An average found by adding the monthly tests and dividing by the number made does not give a true average test but usually a figure somewhat too high, since the amount of milk is usually small when the per cent of fat is the highest.

Cow-Testing Associations

There are several reasons why testing has been neglected by many dairy farmers who really appreciate the necessity and the value of testing from a standpoint of herd improvement by culling unprofitable cows. It must be systematically and regularly attended to to secure satisfactory results, and on many farms there are seasons when rush of other work will cause the testing to be put aside. Again, the keeping of useful records involves a certain amount of book work and calculating—which is ordinarily put off from time to time, until the accumulation is so great that no one has the courage to undertake the task of bringing the records up to date in order to determine the year's production of the various cows. Nothing can be accomplished this way and herd improvement is at a standstill.

Such difficulties can now be entirely overcome by the organization of a cow-testing association. The first coöperative cow-testing association in this country was established at Fremont, Newaygo County, Michigan, in 1905. From that time the movement has been gaining steadily, and in 1921 there were 452 such associations scattered throughout the various states, with prospects for more than five hundred during 1922.

The plan of organization is simple. Fifteen to twenty-five or more farmers adopt the usual form of constitution, elect officers and agree to put a certain number of cows on test. The cost per cow for one year varies from $1.50 to $2.50, depending on the locality and number of cows pledged. The association then hires a competent tester to do the work, and he visits the farm of each member once a month throughout the year. He weighs, samples, and tests the milk of each cow individually, and the per cent of fat as determined by this test is used as a basis for calculating the monthly fat yield. The milk is weighed by the milker for the remainder of the month and entered on the barn sheet. The tester totals the milk sheets, calculates the amount of fat, and also determines the cost of feed consumed by each cow. All of the record work is looked after by the tester, so that membership in one of these associations insures an accurate monthly test on each cow, and a complete summary of production and feed costs at the end of the year. There are additional advantages which accrue to the members of cow-test associations. Testers are often able to give valuable advice regarding the feeding of the cows and to suggest beneficial changes in the rations. They come in contact with different dairymen throughout the month, and in the course of their duties they gain much valuable in-

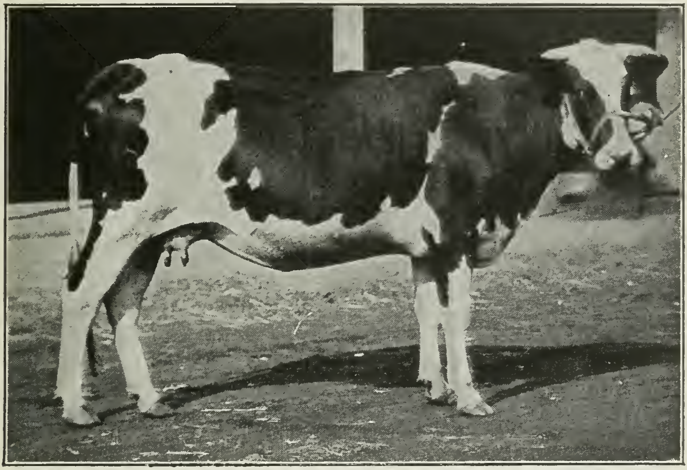


FIG. 33. A poor producer discarded as the result of records kept in a cow test association. Under good conditions of feed and care she produced less than 125 pounds of fat. Her owner did not realize how inferior she was until records were taken.

formation which they will gladly pass on to other farmers. Joining a test association is usually followed by a renewed interest in the dairy herd and a more careful study of the cows as individuals. Of course, the primary purpose of all this work is to afford a definite line on the producing ability of the cows in the herd; and when this information is secured, proper use should be made of it by removing the unprofitable cows and raising the average production. As a concrete example of the results which will follow if this is done, in ten years of cow-test association work the average yield of all cows in the Newaygo County, Michigan, association was increased from 5,354 pounds of milk and 215 pounds of fat to 6,637 pounds of milk and 276 pounds of fat.

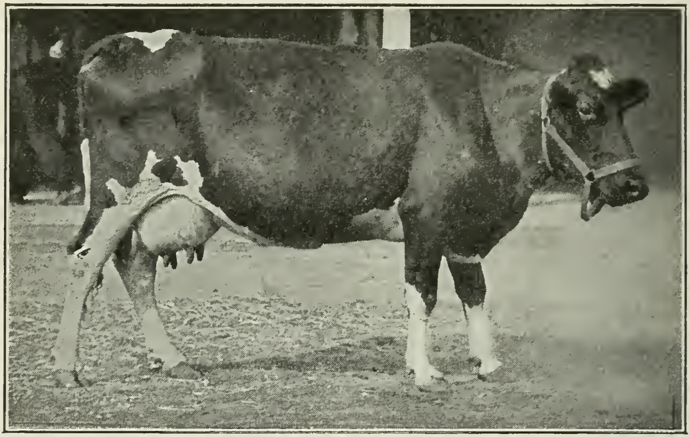


FIG. 34. A profitable grade Holstein discovered by cow test association records. Her owner knew she was a good cow but did not realize her value until the year's records were available. She averaged 410 pounds of fat a year for six years. Income above feed $107.90 per year.

To summarize briefly, the rapid extension of cow-testing associations and the appreciation of the value of carefully kept private records are affording more and more information on which to base the purchase of foundation stock for a dairy herd and to improve the production of herds by culling. In the absence of some accurate record of performance, the dairyman is continuing to work in the dark, and the man who buys milk cows must rely on his judgment of their producing ability from external appearances which can never be as good a standard as the milk scale and Babcock tester.

Judging a Cow by Her Two-Year-Old Record. In keeping records for the purpose of culling out unprofitable cows, the question arises as to how long a young cow should be kept in the herd before it is safe to decide if she should be kept permanently. If a two-year-old produces 150 pounds of fat in a year, does it mean that she will not be a profitable animal when mature? If a group of heifers produce 250 pounds of fat each as two-year-olds, is it probable that some will be excellent cows and some inferior when mature? In other words, to what extent is it safe to judge a heifer by her milking period?

The results of a study made by the author of the lifetime records of 98 cows representing three breeds is given in Table 21.

TABLE 21. RELATION OF TWO-YEAR-OLD RECORDS TO MATURE RECORDS

NUMBER OF COWS	2-YEAR-OLD RECORD LBS.	TOTAL NUMBER LACTATION PERIODS	AVERAGE FAT YIELD MATURE LBS.
2	Less than 100	7	120
9	100 to 150	29	183
28	150 to 200	117	261
26	200 to 250	103	292
21	250 to 300	103	324
9	300 to 350	40	373
3	350 and above	12	449

In this table the records studied are grouped according to the production of the cows as two-year-olds. For example, among the 98 records studied, two cows produced less than 100 pounds of fat in the first lactation period as two-year-olds. Records were available for seven lactation periods of these cows when mature and the average production was 120 pounds of fat.

The data presented show conclusively that the record of the two-year-old bears a very definite relation to her production when mature. In each case, with an increase in two-year-old records a corresponding increase is found for the group as mature.

It is clear from this table that a two-year-old record is a reasonably safe basis upon which to judge the future value of the animal. If the animal has the proper inheritance to be a first-class dairy cow, the fact is evident almost as soon as she freshens the first time. There is considerable variation between individuals which is not shown in the table, although the greater number follow rather close to the average.

If the 98 cows had been culled by their two-year-old record, in one case only would injustice have been done.

From this study it seems safe, in more than nine times out of ten, to divide the profitable from the unprofitable after one year in milk. If the cow at first freshening is reasonably mature and in good condition and no sickness or accident occurs—in other words if there is no reasonable excuse for low production—it will be entirely safe to judge the cow upon the records of this first year. Perhaps the most practical plan to follow when the cow proves inferior as a two-year-old and is to be sold for beef is to keep her until she freshens the second time. She may then be milked so long as her milk production continues to be profitable, and then she may be sold. By this plan the owner has the calf, and oftentimes the calf from an inferior cow, if sired by a high-class bull, will be a satisfactory producer.

Unless the breeding of the cow is such that the owner desires to be very certain before condemning her, he may go even farther than suggested and decide within a few weeks after the first freshening whether or not the heifer is one to be retained. In this case, special care should be given that all conditions are favorable—in other words, that she has had a fair chance.

CHAPTER XIV

SELECTION, CARE AND MANAGEMENT OF THE SIRE

General Importance of Selecting the Sire. It has been pointed out in a previous chapter that the question of getting for immediate use a herd that may be kept at a profit is a question of the selection of the individual cow. It is generally conceded that, taking all dairy cattle into account, about one-third of those raised are unsatisfactory and have to be culled out as unprofitable when records are kept. This results in an enormous loss of feed in the aggregate, not only in raising unprofitable animals but in keeping them until their worthlessness is proved. In this connection one of the first questions to arise is whether these inferior animals which must be culled are the result of inheritance or of environment. In other words, is a good or inferior cow born what she is, or is she made what she is by feed and management when young? The relation of environment during the growing period to the dairy qualities of the mature cow is treated in detail in a later chapter. It will suffice to say here that experimental results lead to the conclusion that the ability of the cow to produce milk—the dairy temperament, as some term it—is almost entirely a matter of inheritance. The high class or the inferior cow is born that way, and not made so by any special treatment when young. In fact, within the limits of ordinary practice the manner of feeding and management of the growing heifer has little if any relation to the efficiency of the mature cow as a milk producer.

If the difference between a cow having a capacity of 10,000 pounds of milk in a year and another that barely reaches 4,000 is a question of parents, it certainly becomes a matter of no small importance to see that the proper parents are provided. Selection of the individual cows must be depended upon to insure a satisfactory herd for present use. With the same emphasis, it may be said that the problem of getting a better herd for the future is a question of having good young stock coming on, and is a matter of breeding. The question of breeding is primarily that of the selection of the right sire. More than 100 years ago one of the great English breeders, looking back over the activities of a lifetime spent in breeding livestock, summed up his experiences in the words, "The sire is half the herd." This statement has ever since been accepted as a fit expression of a most important fact, and has become an axiom of livestock breeders the world over.

Every owner of livestock who gives careful thought to the problem of herd improvement realizes that the main chance for the rapid improvement of a herd lies in the introduction of better blood through the sire. No one would recommend the purchase of a high-class cow and a medium bull as a means of improving a herd. Every animal raised gets half of its inheritance from the sire. From the first cross with a pure-bred bull the offspring of a scrub herd have one-half improved blood. A second cross raises the proportion to three-fourths and a third cross to seven-eighths. When this proportion of improved blood is reached, the animals have essentially the characteristics of the breed represented by the improved sires, and if the inferior animals are culled out the dairy qualities should be practically the same as for pure-bred specimens of the breed. The real objective of breeding operations should be not to raise a few great producers but to raise a high percentage of efficient animals. By proper attention to breeding—and especially to the selection of sires—it should be possible to reduce the proportion of culls gradually, until ultimately it would not be necessary to cull out more than one in ten of the heifers raised.

Results from Using a Pure-bred Bull. One of the most striking demonstrations regarding the value of pure-bred bulls as a means of increasing the productive capacity of a dairy herd is shown by results obtained at the Iowa Experiment Station.[1] A group of typical native cows was brought from an isolated locality in the Ozark region. After reaching the experiment station these cows received the same treatment as that given the regular dairy herd. The cows were divided into three groups for breeding purposes. The original cows in one group, and their descendants, were bred to Holstein bulls, another group to Guernseys, and the third to Jerseys. The thirteen original cows with a total of 74 lactation periods averaged 3,991 pounds of milk and 187 pounds of fat. Thirteen daughters of these cows by pure-bred bulls representing the three breeds for a total of 40 lactation periods averaged 5,556 pounds of milk and 253 pounds of fat—an increase in milk of 39 per cent. Records are reported for five cows of the second generation of grades carrying 75 per cent of improved blood. These animals, including a total of six lactation periods, averaged 8,401 pounds of milk and 358 pounds of fat—an increase over the original scrubs of 130 per cent in milk yield and 109 per cent in fat production. It was noted that the improved blood resulted in a decided increase in persistency of milk flow.

Another instructive example of the possibilities in the way of improving the production of a dairy herd by means of a pure-bred sire is found in the results from the herd owned by the Grand Rapids, Minnesota, Sub-Station. In 1905 a group of cows of native and mixed blood was purchased as the foundation for a herd. The purpose was to demonstrate the possibility, and the methods, of building up a grade herd under practical farm conditions. Complete milk and fat records were kept from the beginning. The average production of the original herd was 196 pounds of fat. Ten years later the average of the herd, numbering 41 animals, was 5,721 pounds of milk and 280 pounds

[1] Bulletin 188, Iowa Experiment Station 1919).

of fat. By further culling the herd to 27 cows, three years later an average production was reached of 7,184 pounds of milk and 358 pounds of fat. A comparison is possible between records of 19 common cows in this herd and of their daughters by a pure-bred dairy sire. These 19 common cows averaged 4,570 pounds of milk and 196 pounds of fat, as compared with 5,028 pounds of milk and 251 pounds of fat from the daughters—an increase of 55 pounds of fat, or about 30 per cent, to be attributed to one cross of improved blood.

Fig. 35. The Guernsey bull, Chilmark's May King, with ten of his daughters. The yearly fat production by these daughters was 119 pounds per year of fat above that of their dams. At ordinary prices for butter fat the income from each of these daughters would exceed that of her dam by nearly $60 yearly.

A Guernsey bull was exhibited at the National Dairy Show in 1921 with ten of his daughters that exceeded the yearly records of their grade dams by an average of 119 pounds of fat.

By the use of pure-bred bulls the average yearly milk production of a California herd, composed originally of inferior animals of mixed breeding, was increased from 5,818 pounds of milk to almost 10,000 pounds.

The records from a bull association in Maryland give the production of 21 cows in comparison with that of their daughters by a pure-bred bull of a dairy breed. The dams averaged 5,560 pounds of milk and 219 pounds of fat while the daughters by the pure-bred sire averaged 6,523 pounds of milk and 263 pounds of fat. The increase to be credited to better inheritance was 1,414 pounds of milk and 62 pounds of fat yearly for each daughter. Other examples of equal significance could be assembled and thousands of farmers have experienced the same results in their herds without having the full records available to make the facts public.

Still another striking example of the economic value of the pure-bred sire is shown by a survey made by the County Agricultural agent of the dairy farms of Lake County, Illinois. The survey included 442 farms selling milk and using a total of 7,045 cows. The results are shown in Table 22.

TABLE 22. RESULTS OF USING PURE-BRED BULLS
(From a Survey of Lake County, Illinois)

SIRE USED	NO. FARMS	NO. COWS	MILK SALES PER COW FOR YEAR
Pure-bred, females pure-bred .	56	941	$284
Pure-bred 5 yrs. or more . . .	95	1,610	267
Pure-bred 2 to 4 years	125	2,098	221
Grade or scrub	214	3,160	173

Note the income per cow on those farms which have used pure-bred bulls for a term of years; it is approximately $100 above that of the herds where grade or scrub sires were in use.

Only the most careful consideration and analysis on the part of the reader will reveal the full significance of these figures. The striking relation between the amount of milk and fat produced and the economy of production has been pointed out in another chapter and an analysis of the causes made. This analysis shows that the overhead expense of keeping the cow—including ration for maintenance, labor, barn room, interest, taxes and risk of death—are practically the same, regardless of the amount of milk produced. The high-producing cow does require more feed than the low producer, but, since maintenance is the same, the additional nutrients are used directly for milk production. It has been pointed out in the discussion of the selection of the cow in a previous chapter that the cow producing 300 pounds of fat a year requires about 25 per cent more feed than one producing 150 pounds.

Let us make an analysis of the figures from the Grand Rapids Sub-Station herd. The original herd averaged 196 pounds of fat and 4,666 pounds of milk. The herd after 13 years averaged 7,184 pounds of milk and 358 pounds of fat, an increase of 2,518 pounds of milk and 162 pounds of fat. Assuming these cows were milked six years each, the total increase in production per cow for those having the improved blood would be 15,108 pounds of milk and 972 pounds of fat over the average of the original unimproved herd. At $2.50 per hundred pounds for milk, the additional milk would be worth $377.70. If the 972 pounds of fat was sold at 45 cents a pound the increased income would be $437.40. Against this it would be fair to charge the cost for additional feed which would be necessary on account of the greater production. This additional amount would in this case not be over 900 pounds of grain a year and a small increase in roughage. If concentrates are worth $30 a ton, the additional feed would for the six years amount to something like $95 a cow, leaving a net gain of $272.70 if the milk were sold at the figure mentioned, or of $342.40 if the fat were marketed. The use of pure-bred bulls in this herd made possible an annual income of $57.06 more for each cow in the herd than would have been realized from the original stock.

The data from the Iowa Experiment Station show an increase of 66 pounds of fat yearly from the daughters of a pure-bred bull as compared with the scrub dams. At 45 cents a pound for fat, the daughters gave an income of $29.40 a year more than their dams. Assuming that one-half of the offspring were males and of no value, and that the heifer calves were raised and milked six years each, a service fee of $88.20 could have been paid for each scrub cow bred to the pure-bred bull. It is clear that given a herd of low-producing cows, and looking forward for a term of years, the axiom, "The sire is half the herd," is really a conservative statement.

Importance of the Sire in the Pure-Bred Herd. With the pure-bred herd, even more is at stake in the selection of the herd sire than when the herd is a grade one used only for producing market products. Furthermore, with each progressive stage of development the problem of getting a sire that will result in improvement becomes increasingly difficult. In fact in the highly developed herds it becomes a serious question to select an animal for breeding purposes good enough to hold the advancement that has been made. While almost any pure-bred bull of good inheritance will increase, or at least maintain, the standard of an ordinary grade herd, only an animal of the best inheritance will make it possible to even maintain, to say nothing of improving the production of, a highly developed pure-bred herd. All successful breeders recognize that the whole future of the herd is at stake when the bull is selected. As soon as one animal is decided upon, they begin considering what to use next.

A study of the history of any unusually successful breeder of the past will generally reveal that his success was based largely upon one or more great transmitting sires. The great work of the Collins Brothers in establishing the Shorthorn breed in the eighteenth century was based largely upon the bull Favorite. The early popularity of the Jersey breed in America was made possible largely as the result of the great transmitting bull Stoke Pogis 3rd. This bull was the founder of a family that has been bred successfully for 40 years. Golden Lad, another great transmitting bull of the same breed, still exerts an important influence, although he has been dead nearly 30 years. The Guernsey bull, May Rose King, and the Holstein, Hengerveld De Kol, made famous the herds where they were owned and left a permanent impress upon their breeds.

Difference in Transmission of Dairy Qualities by Different Bulls. One of the striking and vastly important facts that has to be taken into account is the wide variation in the way different bulls transmit dairy qualities. This fact is illustrated in Table 23, compiled by the author from the records of the Jersey herd owned by the University of Missouri. This herd is all descended from three cows and complete milk and fat records are available for 30 years. The comparisons given are between the production of the daughters of various sires used and the dams of these daughters. The records given appear low, but this is explained by the fact that all the daughters of each sire are included in each case, that two-year-old records are included, and that the cows were not pushed for high production. The conditions under which the herd was maintained during the long period represented, while not exactly uniform, did not vary sufficiently to influence the data materially. In case a daughter had only two of three lactation periods the comparison was made between these and the corresponding periods for the dam. The records for the daughters of Sultana's Virginia Lad represent two-year-old records only. The number of animals represented in the various groups varies but averages about ten. The figure 4,381, for example, given as the milk production of the daughters of Missouri Rioter, is an average of the production of each daughter of Missouri Rioter, which is found in turn by taking the average of all the lactation periods of the particular animals.

TABLE 23. INFLUENCE OF THE SIRE SHOWN BY A COMPARISON OF THE RECORDS OF DAUGHTERS WITH DAMS

	AVERAGES FOR ALL LACTATION PERIODS	
	DAMS	DAUGHTERS
MISSOURI RIOTER		
Milk Yield, lbs.	5,380	4,381
Per cent fat	4.35	4.93
Yield of fat, lbs.	234	216
HUGOROTUS		
Milk Yield, lbs.	4,969	4,576
Per cent fat	4.66	5.35
Yield of fat, lbs.	231	216

Table 23, continued

	Average for All Lactation Periods	
	Dams	Daughters
Lorne of Meridale		
Milk Yield, lbs.	4,559	6,050
Per cent fat	4.85	4.81
Yield of fat, lbs.	221	291
Missouri Rioter, 3rd		
Milk Yield, lbs.	4,775	8,005
Per cent fat	4.98	4.80
Yield of fat, lbs.	238	384
Minette's Pedro		
Milk Yield, lbs.	5,321	5,376
Per cent fat	5.03	5.04
Yield of fat, lbs.	268	271
Daisy's Prince of St. Lambert		
Milk Yield, lbs.	5,362	3,932
Per cent fat	5.07	5.03
Yield of fat, lbs.	269	198
Brown Bessie's Registrar		
Milk Yield, lbs.	6,069	4,607
Per cent fat	4.94	4.97
Yield of fat, lbs.	300	229
Fairy's Lad		
Milk Yield, lbs.	6,219	6,169
Per cent fat	4.80	5.24
Yield of fat, lbs.	299	323
Sultana's Virginia Lad*		
Milk Yield, lbs.	5,349	7,722
Per cent fat	5.17	5.76
Yield of fat, lbs.	277	445

*Records of both Dams and Daughters are as two-year-olds.

Very interesting and instructive comparisons may be made of the comparative values of these bulls. The daughters of Lorne of Meridale, for example, averaged 1,491 pounds of milk more per year for their entire lifetime than did their dams. Eleven out of a total of thirteen were superior to their dams. If thirty daughters of this bull had been milked in one herd their total production per year would have exceeded that of their dams by 44,730 pounds. At $2 a hundred for milk the income would be $894 per year more than for their dams. If the animals were daughters of Missouri Rioter, they would have produced 999 pounds each less than their mothers in a year, or a total of 29,970 pounds of milk less than their dams. At $2 a hundred this would be a decrease of $599. It would apparently make a difference of $1,493 in the gross income whether these cows be daughters of Missouri Rioter or of Lorne of Meridale. If we make the comparison directly from the average yield of the daughters the difference would be 50,070 pounds of milk.

The figures for the daughters of Sultana's Virginia Lad include the first sixteen daughters sired by this bull in the University of Missouri herd. They averaged in their first lactation period 2,373 pounds of milk and 168 pounds of fat more than their dams at the same age. On a percentage basis, this is an increase of 44.4 per cent in milk and 60.7 per cent in fat. The type of daughters was also far superior to that of their dams. The value of such a bull in a herd can hardly be overestimated. The fact should also be noted that all the daughters are included. By using figures from a selected group representing only a portion of the offspring of an animal, it is often possible to misrepresent the real breeding qualities of the bull in question.

Another remarkable bull was Emblagaard Tritomia Homestead, a Holstein owned by the University of Illinois. The yearly production of his first ten daughters as two-year-olds and of their dams at the same age is as follows:

	DAMS	DAUGHTERS
Lbs. milk	9,594	13,504
Per cent fat	3.21	3.47
Lbs. fat yield	308	469

The average increase in production of the daughters over that of their dams was 3,907 pounds of milk and 161 pounds of fat. On the percentage basis, the increase was 40.7 per cent in milk and 52.2 in fat.

These examples so far given have been selected because the records of the dams are available for comparison with those of the daughters. A large number of very striking examples could be assembled showing the remarkable transmitting ability of certain well known bulls in all the dairy breeds. One of the most striking of these examples is that of the Holstein bull Sir Pietertje Ormsby Mercedes. The ability of this animal to transmit milking qualities was phenomenal. Sixty-one daughters of this bull, of which forty-two were not yet mature at the time the record was made, averaged on official test 17,816 pounds of milk and 643 pounds of fat in a year. Of these fourteen exceeded 800 pounds of fat and twenty produced in excess of 20,000 pounds of milk during the year of test. This remarkable bull at the same time was an outstanding animal of the breed in conformation and transmitting this to his offspring to a high degree as is shown by a long list of prizes won at the leading shows over a term of years.

Fauvic's Prince, a Jersey sire of recent years, is another outstanding example of a prepotent sire. The first seventeen daughters of this bull freshening at an average of 26 months have averaged 558 pounds of fat in a year under official test.

Cause of the Wide Variation in Prepotency of Bulls. It is easy to understand why a pure-bred bull should transmit the characteristics of his breed more uniformly than does a scrub, or even a grade, animal. His ancestors have been selected for generations with a certain purpose in view. However, it is not so clear why there should be such extreme variations in the way pure-bred bulls of the dairy breeds transmit milking characteristics. Why should the daughters of one bull be uniformly high-producing animals while those sired by another are medium or even inferior? The variation is undoubtedly to be attributed to a difference in the combination of hereditary factors. The dairy cow of today has been developed until she is an abnormal animal from the standpoint of nature. There is, of course, no means of knowing the capacity of the original wild cow as a milk-producing animal. It is safe to assume that she produced not over 1,500 to 2,000 pounds of milk in a lactation period of five or six months. The high-class dairy cow of today produces more milk in a month than her wild ancestor did in an entire milking period. Moreover, she will continue to produce milk at least ten months out of each year. Since the production of large quantities of milk is not natural to the species, but acquired, the characteristic is easily lost and many revert to the older types and are the unprofitable producers that have to be culled from the herd. Unless constant selection of breeding stock is made, not only will no progress be made but the tendency will be actually backward. To retain the milking qualities of a good grade at a uniform level requires the use of a prepotent bull better bred than are the cows. To improve or even retain the standard in a highly developed herd becomes exceedingly difficult.

How the Sire is Selected. The selection of the dairy sire is generally based upon one or more of four points:

(1) Breed.

(2) Type and appearance.

(3) Pedigree, including with this all facts regarding ancestry such as milk records.

(4) Characteristics of offspring.

In most cases more than one of these points are taken into account. For example, the most common basis for selection is by breed, type, and pedigree combined.

The Breed. As a rule the question of what breed the sire shall represent is answered at once by the fact that the herd for which the sire is to be purchased is either a grade or a pure-bred herd which is maintained according to a well defined breeding plan on the part of the owner. An owner of such a herd is not satisfied by selecting a bull by breed alone, however, but he also considers type and pedigree. Many owners of herds less well developed do buy bulls with little attention to anything farther than knowing the animals belong to the breed they are using. Although the question of crossing is considered in detail elsewhere, warning may be repeated here against unnecessary crossing of breeds. The bull selected should be pure bred of the breed to which the cows belong, or, in case grading up from mixed stock is to be begun, of the one selected as best suiting the purpose. Under these conditions it is often necessary and advisable to use a bull on cows containing more or less blood of other breeds. However, deliberately crossing breeds with the expectation of getting better results by that means is a great mistake.

Type and appearance. There is some difference of opinion as to the proper weight to be given to type in the selection of a bull. The emphasis to be placed upon type undoubtedly depends mostly upon the objective of the purchaser. If the purpose is to develop a herd for milk production with little attention to show ring type in the cows, less attention is necessary to this point than is desirable when the animal is to be used in a pure-bred herd where beautiful conformation is a strong asset. The view of the author is that there is little relation between the type of a dairy bull and the milking qualities of his daughters. The beef-bred bull shows in his own bodily conformation the beef qualities for which he is bred and which he may reasonably be expected to transmit to his offspring. Likewise, it is possible to draw some conclusions from the type of a dairy bred bull as to the conformation of his daughters. Milk production, however, is the function of a gland, and has little to do with body conformation. For this reason the appearance of the bull offers far less basis for judgment as to the milking qualities he will transmit than it does for the probable type of his daughters. The type of the bull should not be ignored, since it is important to have cows of good conformation if possible; although for the practical milk producer, animals of milk-producing ability are the first consideration. It is always well to insist that the animal selected be from medium to large size for the breed he represents and full of vigor and nervous energy. Many men buy bulls, especially those that command only a moderate price, without going farther than knowing that the animal is pure bred and that he is a good looking specimen. He should have at least reasonably good type, but it would not be advisable to make the decision as a rule on this point alone. On the other hand, the owner of a highly developed pure-bred or high-grade herd where conformation of the cows is second in importance only to milk production, one cannot be too careful on this point.

Selecting by pedigree. A large majority of the bulls used are, and should be, selected largely upon their pedigree and the milk records of their ancestors. A careful consideration of the pedigree, with some attention to the individuality of the animal, is the best means of selecting a bull—next to that of judging him by his daughters. The experienced breeder of pure-bred cattle has usually given some attention to the question of pedigrees and knows how to interpret them. The person who has not had opportunity to become familiar with the subject should either do so, or preferably get some one with this knowledge to assist him in making his choice. There is no better way for the inexperienced as a rule than to go to a reliable, experienced breeder and rely largely upon him to supply what the buyer needs.

In studying the pedigree, the mother of the animal in question should be given first consideration. Many experienced breeders believe that dairy qualities are inherited stronger from the sire than through the dam. There is some question concerning this view, but at any rate the mother of the bull chosen should by all means be as nearly as possible the perfect cow of the buyer. The buyer should make it a point to see the dam if possible and satisfy himself as to her qualities. If the purchase is to be made by mail, a photograph of the dam should be insisted upon. In addition to the dam being an animal of proper size and conformation, satisfactory evidence should be available—preferably in the form of an official record—as to her milk producing ability. Next in importance to the dam is the sire, to be judged mostly by the dairy qualities of his daughters if they are in milk, by his sisters, and especially by his dam.

Too much attention should not be given to ancestors three to four generations back. In the third generation back the animal has eight ancestors, each of which supplies 12.5 per cent of the blood. The fourth generation contains sixteen ancestors each supplying 6.25 per cent of the total inheritance. Frequently the owner of a pure-bred bull speaks with great pride of ancestors back three to four generations, and at the same time does not know anything concerning the immediate ancestors, even of the dam.

Another important consideration is to make sure that the dam of the bull under consideration is not an unusual producer in a family of inferior animals. Such a cow is not a good dam for a bull even though she may have an excellent record herself. If a certain cow is a splendid producer, but the remainder of the family are ordinary or inferior in this respect, she is not typical of her inheritance and cannot be counted on to transmit her own good qualities. The chances are that she will transmit characteristics nearer the average of her family. The dam, then, should not only have a good record herself, but if possible be one of a large group of high-producing cows. She should represent a family in which it is common, and not exceptional, for the cows to be high producers. The same statements apply to all females in the pedigree, but with less importance to those farther removed from the bull whose pedigree is under consideration. If the dam of the sire comes of a high-producing family of this kind it is also quite significant, and greatly increases the chances that the characteristics desired will be transmitted. If the sire of the bull under consideration has daughters in milk, naturally they should be uniformly good.

It is also well to take into account the opportunity which the animal in question has had to make a showing. It is clear that a bull which has a half-dozen high record daughters is not necessarily a good ancestor for a herd bull if he also had three dozen daughters that could not get into the Advanced Register at all. Again, a record made in a herd where only ordinary care is given to the cow appears to disadvantage compared with records made in herds where every cow is forced to the limit. A bull, then, whose daughters have been owned in a herd where every opportunity is given for maximum results has a great advantage over the bull whose daughters have received ordinary treatment. It is unfortunately a difficult matter ordinarily to get the information necessary upon which to pass judgment along these lines.

In studying milk and fat records in pedigrees care should be taken to make certain what the records mean. Note whether or not the records are given in terms of butter fat or butter. Records of Holstein cows are usually given in butter calculated on the 80 per cent fat basis, while the records of other breeds are generally given in terms of butter fat.

Records covering a year should certainly be given more consideration than short time records. This is especially true with reference to the percentage of fat. In fact, an unusually high percentage of fat for seven days is largely a result of the condition of the cow at the time of freshening and the way in which she is handled. A high fat percentage for seven days does not necessarily indicate that a cow will produce milk with a high fat content throughout the year. A farmer who is led to select a bull from a cow with a great seven-day butter fat record made as the result of abnormal per cent of fat must not expect the daughters of this bull to inherit this high per cent of fat.

An unfortunate practice has been in vogue in recent years in the preparation of pedigrees, especially for public-sale catalogues. So much attention has been given to milk and fat records that the attention of the reader is at once attracted to the name of the animal that has no records below. To avoid this situation, records of ancestors or distant relatives are put in the vacant place with an explanatory statement in small type, for example, "By a three-quarters brother to the sire of" followed by the records. The object of such statements is to make the pedigree look better than it really is, without making any misstatements, and to mislead the careless reader.

It must be conceded that at times animals selected with the best of judgment and after careful consideration of the pedigree prove very disappointing. Such experiences unfortunately are only too common. Some excellent examples are found among the bulls listed with the records of their daughters in Table 23. Missouri Rioter, Daisy's Prince of St. Lambert, and Brown Bessie's Registrar, all had good pedigrees, but their use was disastrous as shown by the results. The pedigree of Brown Bessie's Registrar was especially strong in records of butter production. Each female in his pedigree for three generations had a butter record. His dam was a daughter of a bull with over sixty tested daughters. His sire had a very large list of good producing daughters. In these three cases evidently the pedigree was not a reliable indication of the bull. In the same list Missouri Rioter 3rd and Fairy's Lad, likewise selected upon the basis of pedigree, were excellent transmitting bulls, although no one familiar with Jersey pedigrees would have ranked them above those mentioned which proved to be so inferior. In fact it is not unusual for some of the most famous transmitting bulls, like Hengerveld De Kol, to show little or no evidence of their unusual breeding powers in their pedigree.

While a good pedigree can not always be relied upon to insure a satisfactory transmitting animal, it is the best, and in fact the only, basis for selecting the young and untried animal. It should, however, be emphasized here that, while selection by pedigree is at times disappointing, after all, if proper care and judgment is exercised in the majority of cases at least, the results will be reasonably satisfactory. In a previous paragraph it was pointed out that the appearance of so many cows lacking in what is now considered satisfactory milking ability is no more than to be expected in view of the abnormal extent to which the milking functions have been developed. The same viewpoint seems sound regarding the difficulty of securing a bull that will transmit dairy qualities to such a degree as to satisfy the modern standard. It we were content to use the cow as nature made her, little culling of herds would be necessary and the difficulty of selecting a suitable bull for breeding purposes would vanish.

The Proved Sire. A man who has a dairy herd already highly developed should, whenever possible, find a bull for a herd sire that has already demonstrated by his daughters his ability to transmit the dairy qualities wanted. Unfortunately the common practice followed by so many of using a bull two years and then selling him to the butcher makes it impossible to judge of the value of most bulls until too late. The movement under way of forming bull clubs offers great possibilities along this line. By the exchange among the groups of members as planned by these clubs it will be possible to retain a bull until he is old enough to show breeding value. In this way, many bulls will be discovered that are wonderful breeders.

A study of the methods of the great breeders of the past will show that they followed this plan of judging a bull by his offspring rather than by his ancestors; and this was unquestionably one of the main reasons for their success. Whenever possible, it is wise to retain a bull until the results of his breeding can be ascertained. Then if his daughters are not satisfactory, the sooner he is sold the better. There always exists the possibility of finding a great bull like Hengerveld De Kol, Golden Lad, or many others of wonderful prepotency. To be sure, there are many difficulties to be met with in getting an animal of this kind, and it is not always possible, or at least practicable, to do so.

The bull known to transmit dairy qualities of a high order is appreciated today as never before, and is certain to bring a long price when once his value is known. As a rule, it is only the breeders of pure-bred cattle who can spend the necessary time and money to locate a bull of this class. The smaller breeder, however, should always be on the outlook, and occasionally a bull of this class may be located where his value is not appreciated.

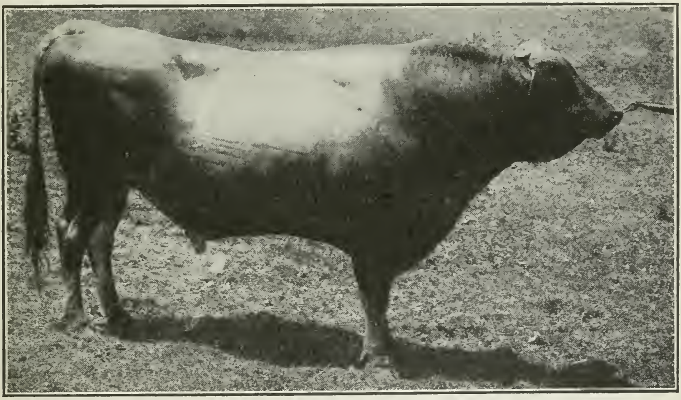


Fig. 36. Jersey bull, Sultana's Virginia Lad. Purchased by the author as a proved sire from the appearance of his daughters, none of which had records. His first 16 daughters, in the University of Missouri, all from pure-bred cows, averaged 168 pounds or 60.7 per cent more than their dams.

Instructive examples of the possibility of selecting a proved sire are also found in Table 23. Both Lorne of Meridale and Sultana's Virginia Lad were purchased as proved sires. In both cases daughters were mature and in milk at the time the bulls were purchased, giving an opportunity for safe judgment as to their transmitting abilities. Sultana's Virginia Lad was purchased to be used in a herd where the cows all had Register of Merit records, although there was not at the time a single Register of Merit record in his pedigree. His daughters, however, were a remarkable lot, uniform in type and production, and the private records of the owner showed that they were unquestionably heavy producers. Care was taken to learn how many daughters he had and to see all of them, and no inferior ones were found. His mother was studied carefully, and found to be a splendid animal and to have a group of excellent sisters by the same sire. This bull would have been much more valuable in the beginning had Register of Merit records been made of his female relatives. However, when his daughters came into milk there was no question of his remarkable breeding qualities. Records available of his first sixteen daughters in the University of Missouri herd show an increase in production over the dam in every case, the average being 60.7 per cent increase in fat.

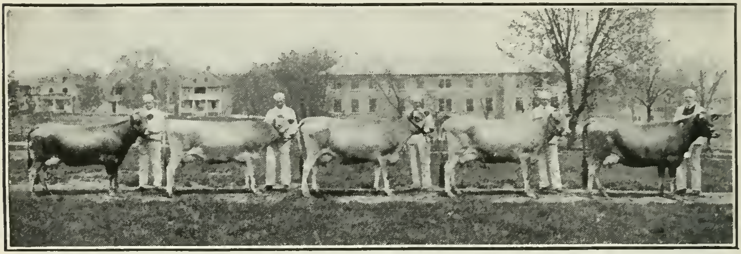


FIG. 37. The first five daughters of Sultana's Virginia Lad, shown in Fig. 36. These heifers as two-year-olds averaged 511 pounds of fat. Their dams at the same age averaged 274.

Much as it is desirable to use only a proved sire, it is generally very difficult to secure one when needed. Great bulls can seldom be bought. Many bulls are sold for slaughter before their value as breeders is known and when a bull with great transmitting ability is discovered he is not usually for sale. As a partial remedy for this situation it is suggested that breeders of pure-bred herds especially buy a young bull of good breeding and use him to a limited extent, then loan him out until his daughters come into milk. The plan is especially recommended of sending two or three good cows for breeding to a bull recognized as a great transmitting sire. Bull calves from this mating should then be tried out in a limited way as suggested.

Age as a Factor in Selecting the Bull. Sometimes the claim is made that a mature bull is more prepotent than a young one, although there is no evidence to prove such an assertion. According to the modern view of heredity there is no possible way for the transmitting ability of the animal to change as the result of age. An animal of either sex receives a certain combination of hereditary characteristics at the time the ovum from which the animal comes is fertilized. This combination determines the characteristics of the animal and what it in turn will transmit. A young bull is generally preferred, especially by the average dairyman, mainly because a young one is easier to handle and to ship than an older one. Furthermore, on account of improper care the aged bull is an uncertain breeder. The typical farmer buys a bull calf about a year old, keeps him two years, then sells him to the butcher in place of trading with a neighbor or buying one old enough that his ability to transmit the desired qualities may be judged. The reluctance of many breeders to handle the mature bull is a serious obstacle to overcome in any programs looking toward the improvement of the great mass of dairy cattle. The average dairyman prefers to continually experiment with a young bull rather than make use of a proved bull if one has by chance been kept in his neighborhood long enough to make this possible. There is no reason, however, for choosing an aged bull unless evidence is at hand that he has the power to transmit what is wanted. If a bull is to be purchased on pedigree alone, let it be a young bull by all means, since he then has all his life before him. Furthermore, the fact that the heifer calves of a bull are attractive at that age and have indications of making satisfactory cows by no means makes him a proved sire so far as the milking qualities of his daughters are concerned. Oftentimes very promising calves develop into mediocre cows when mature.

Relation of Dam's Age to Prepotency of Bull. The question also arises at times if a bull which is the first calf of a heifer is as likely to transmit dairy qualities of a high degree as is a son of an older cow which has made large records. On the basis of the discussion in the previous paragraphs, the answer would be that there is no basis for any such conclusion. It is true that the highest prices are generally commanded by bulls from older cows and that the first calf of a heifer is not so much sought after. This results from the fact that in the case of the older cows their merits are known, since they have had opportunities to make official records. The heifer in milk for the first time has her reputation to make as a producer. It is wise not to select the calf from the two-year-old as a future herd sire until the heifer has had opportunity to demonstrate her good qualities.

Feeding During the Growing Period. The bull calf designed for breeding purposes should be well fed during the growing period, in order that he may develop to the full limits of his inheritance. An animal that is poorly fed during the growing period may fail to reach his full size. His progeny will not be smaller on account of the sire's being undersized from the same cause; but it is impossible to judge from the appearance of the animal whether his small size is due to inheritance or to feed. A male breeding animal that is small and undeveloped for his age is always looked upon unfavorably.

The male calf is generally raised with the heifers for the first four or five months, receiving the usual ration of the calves in the herd. Skim milk serves the purpose just as well as whole milk, and at times it is actually better. At the age of about five months it is well to separate the bulls from the heifers. The milk feeding may be discontinued at the usual age of six months, or it may be continued for several months longer for the sake of securing the most rapid growth. A rather liberal grain ration should be fed. If good legume roughage is fed, almost any mixture of grain will serve the purpose. Corn and oats in equal parts are a suitable mixture, or equal parts of barley, oats, and bran. The addition of a small proportion of oil meal would also improve mixtures of farm-grown grains. Some prefer to feed the bulls the same grain mixtures as that received by the cows in milk, and this should meet all requirements. At six months of age, and before weaning, the bull will be consuming about four pounds of grain daily. After the milk is removed, the grain ration may be increased to possibly five pounds daily. This, fed with good clover or alfalfa hay, will insure a rapid growth. While there is no advantage in getting the bull fat while young, on the other hand there is no special harm done if he appears a little smooth in form at this age since this tendency will disappear later. The bull reaches maturity in size at about the same age as the cow of the same breed. Bulls of the Jersey and Guernsey breeds when well fed reach their full development of skeleton some time between the ages of four and five years. The animals of all breeds increase in weight for about two years after the skeleton has ceased to grow.

Age for Breeding. Bulls of the early maturing breeds, if well fed, are old enough for light service by the time the age of 12 months is reached. One or two services a week is all that should be allowed from the age of 12 to 15 months. As the animal becomes older and better developed the amount of service may be increased. A well fed, mature animal might serve for a herd of 200 cows if the time of breeding were distributed throughout the twelve months. As a rule, the greater proportion of a herd is bred to calve at a certain period of the year, and for this reason ordinarily one bull is not expected to serve for more than about fifty cows. The breeding powers of the bull are at the best between the ages of two to five years. A bull that has been properly handled when young and sufficiently exercised when mature may retain his breeding ability to the age of 12 or 15 years, or even occasionally longer. As a rule, however, the bull past eight years old is a slow and uncertain breeder.

Ringing and Dehorning the Bull. When the bull is about one year of age a ring should be put in his nose as a convenience in handling and as something of a protection in case the bull becomes vicious and attacks the herdsman. A punch made for the purpose and sold by dealers in stockmen's supplies may be used in ringing the bull. The ring is slipped through the opening the punch has cut in the cartilage between the nostrils as the instrument is withdrawn. A trocar such as is used in severe cases of bloat is also used sometimes for the same purpose. The instrument is forced through the cartilage division between the nostrils and withdrawn leaving the cannula in the opening. One end of the opened ring is then passed through the opening as the cannula is withdrawn. The ring should be filed or sand-papered smooth after it is closed to remove the rough edges formed by opening the ring and tightening the screw.

There is some difference of opinion regarding the advisability of dehorning the bull. The claim has been made by a few breeders that dehorning reduces the prepotency of the bull or that it in some way is detrimental to his breeding powers. There is not the slightest evidence, however, that dehorning has any effect upon the breeding qualities of the animal, but it does undoubtedly injure his chances in the show ring. For this reason the bulls at the head of highly developed herds, where it is important to maintain the best possible appearances of the sires, are seldom dehorned. However, in herds kept primarily for producing market products, and this includes the big majority, the bull is seldom allowed to retain his horns. A bull is more or less dangerous under any circumstances but certainly less so when dehorned. For this reason it is recommended that all bulls, except those at the head of very valuable pure-bred herds, be dehorned. It is best to allow the bull to retain his horns until possibly a year and a half or two years old and until he realizes that he has them and for what purpose they are designed. If he is then dehorned the effect upon the bull is much more marked than is the case when the horns are removed as a calf.

Feeding the Mature Bull. The bull which has reached his growth should be kept in moderate flesh but never allowed to get fat. The animal is in the best breeding condition if fed rather liberally and sufficiently exercised to prevent him from becoming over fat. Legume hay, such as alfalfa, clover, soy bean, or cow pea, meets the demand for roughage to the best advantage and should be fed in such amounts as will be eaten readily. A mature bull will eat from 10 to 15 pounds if the roughage is of good quality. Silage in moderate quantities is fed by some although there is a rather general belief—for which, however, there is no experimental evidence—that silage tends to impair the breeding qualities. In addition to a good roughage, the bull will need a limited grain allowance. From four to eight pounds a day is generally sufficient, depending upon the size of the animal. Many cattle men feed the bull from the same mixture as that used for the cows and there is no objection to this practice unless it is one of economy. When the bull receives a legume roughage, a ration containing a smaller amount of protein and less variety of grain will serve every purpose. A mixture of corn or barley three parts, oats or bran two parts, and linseed one part will be entirely satisfactory. Whenever practicable opportunity should be given the bull to secure all or most of his living by grazing for a period each year. However, the desirability of allowing him this privilege is not sufficient to justify turning him out to pasture with the herd and experiencing all the disadvantages which this practice involves.

Housing the Bull. The bull should not be allowed to run loose in the pasture with the herd. In the first place, it is a dangerous practice, as it gives abundant opportunity for the bull to attack a person unawares or in a place where escape is difficult. Furthermore, a record of the date of breeding of the cows cannot be kept, and no dairy herd can be handled to best advantage without such records. Cows are often served younger or sooner after calving than the owner intends. The bull running with the herd exhausts himself until he becomes an uncertain breeder sooner than should be the case.

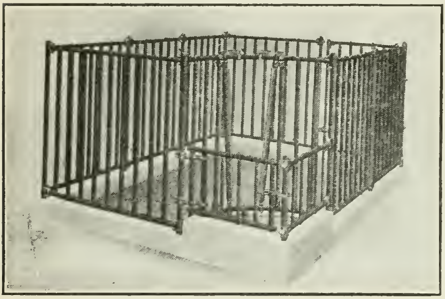


FIG. 38. A modern bull pen
A steel pen of heavy construction with a corner manger is the most suitable type of bull pen

A box stall 10 by 12 feet is suitable for such an animal, when he is to be kept in the barn. A strong paddock outside should be provided, with a door from the box stall. In all except severe climates the bull is best housed in a shed built in the paddock. All the protection necessary is a good roof and tight walls to serve as a windbreak. Exposure to any but severe weather is beneficial rather than injurious to the breeding bull. Such open-air treatment, with the precaution that the animal gets plenty of exercise, will keep the bull in the best breeding condition, and he will be almost as sure a breeder at eight or nine years as at two. This open-air treatment causes the animal to look somewhat rough, and for this reason does not find favor with those who make a business of selling breeding stock, since the appearance of the herd bull is of importance in making sales.

For those who prefer the herd bull to make the best appearance at all times, the best plan is to use a box stall in the barn, and see that the animal is outside only on fair days. Special attention should be given to exercising the bull under these conditions.

Exercising the Bull. While nearly all successful breeders keep the bull away from the herd, there is great need of an improvement in the way the bull is handled when confined. Too often he is confined in a dark, dirty stall without exercise from the time he is a calf. Such treatment is certain to result in weakening of the breeding powers, and often the animal becomes entirely impotent while scarcely more than mature. As a result of such treatment, by the time the sire is old enough to have daughters in milk so that his value as a sire may be judged, he is too often valueless for breeding purposes. The main points to be observed in keeping a bull in good condition to retain his breeding powers are to avoid excessive use when young and to give plenty of exercise and a moderate ration when mature.

When more than one bull is used, the bulls may be kept together advantageously in a suitable paddock. There is no trouble or danger in keeping two or more bulls of any age together, if they be dehorned. One of the chief advantages is that they take more exercise than when confined alone.

One of the most common plans of exercising the bull when closely confined is by use of a tread power. In some cases he operates the cream separator regularly, and occasionally other machinery. The power is adjusted to keep the bull walking at rather a slow pace as long as is wished. Another plan is to arrange a long sweep on a post and tie the bull at the end, and allow him to revolve the sweep by walking. Another plan followed is to arrange an overhead cable upon which a ring is placed from which a chain hangs. The bull is tied to this chain and can walk the length of the cable.

Proper Handling of the Bull. The bull of a dairy breed is more liable to be vicious than one of a beef breed, since the former is more active and has greater nervous energy than the more sluggish beef animal. In handling bulls it should always be taken for granted that they are dangerous. It is never safe to trust them, and it is usually one that has been considered perfectly safe that injures some one.

A bull should be treated kindly, but never petted, even when a calf, and anything even bordering on teasing must be prohibited. The bull is best let strictly alone except when it is necessary to handle him. He must always be handled in a firm manner and made to understand that a man has power to control him and must be respected. The man handling a bull must not show fear of the animal, and must take care that the bull does not gain the upper hand. The animal should be thoroughly trained to being tied and led when a calf. If this is done, he never forgets it, and may be tied or led at any time later, even if handled only at long intervals.

Sufficient exercise is one of the most important factors in preventing a bull from becoming vicious. It is also well to have his stall or paddock so located and constructed that he can see other cattle and the attendants. Solitary confinement in an isolated box stall is not conducive toward the development of a quiet disposition in a bull.

Care should be taken that the bull never has a chance to learn to use his really enormous strength in breaking fences, gates, tie straps, etc. Keeping everything strong and in good repair will do much to hold the bull in subjection.

In leading a bull a staff should be used. In case he is regularly tied in the barn, a large, strong halter may be used, or a special bull stanchion, as preferred.

CHAPTER XV

CATTLE BREEDING[1]

It would require volumes to fully set forth the present knowledge and theories covering the subject matter embraced in the heading of this chapter. Consequently the material is presented in a condensed form, and represents only a brief review of some of the more complete works on breeding.

As far back as we can trace authentic records we find animals under domestication, and the earliest reports of domestic animals indicate that they were already much modified from their wild ancestors. During the pastoral age, when men wandered from place to place with their herds and flocks, there was more or less interbreeding between the domesticated animals and their wild cousins, which may account for the early establishment of differing species in localities where men roamed.

Such early improvement as is shown by the domestic animals over the wild is no doubt largely due to a crude method of selection which is exercised instinctively by the herdsman whose living depends wholly or in part on the produce of his animals. This process of improvement was exceedingly gradual, and no very marked progress is traceable previous to the time of Robert Bakewell, of Leicestershire, England. He is now recognized as the pioneer in what may be called the improvement and development of modern livestock.

Methods of the Pioneer Breeders. Bakewell's work was with sheep, horses, and cattle; his method was the fixing of desirable types by careful selection and close breeding of the individuals conforming most closely to his ideal of type. Bakewell's breeding operations were carried on during the last half of the eighteenth century and though he worked without the aid of the recently developed knowledge of genetics, he nevertheless pursued the course which is now definitely followed in all efforts to concentrate particular characters; that is, the close breeding of animals which possess those desired traits. His pursuit of this policy led to much adverse criticism by his contemporaries; but the splendid success of his methods caught the attention of the thoughtful animal breeders of his day.

---

[1] By M. H. Fohrman.

We find success attending the breeding of Shorthorn cattle by the Collings brothers of England when they adopted Bakewell's methods, although they sought to establish their ideal type through the use of bulls more particularly than through the female lines, and their progress came by using closely inbred bulls. Thomas Bates continued the work of improving Shorthorn cattle by concentrating the blood of desirable females, and he relied as much on pedigree in selecting his bulls as on individual excellence. Thomas Booth, Amos Cruikshank, and William Duthie accomplished their splendid results by selecting animals of the desired type and fixing this type by close inbreeding.

Similar work by Dauncey resulted in the establishment of a strain of high-producing Jersey cattle in England, and from this fountain head the foundation of the St. Lambert family was drawn.

In the light of our present knowledge of heredity we can offer an explanation of the success which attended the practice followed by these pioneers. The results obtained speak for themselves, and these men, guided by their maxim that "Like begets like," set a pattern followed to the present day. Beginning with foundation stock of assorted breeding, but all conforming to a definite type, the surest and quickest method of fixing this type was to breed and interbreed these animals and their descendants, without recourse to outside blood, until such time as the persistence of undesirable traits called for the introduction of a counteracting influence. By pursuing this method of close breeding and careful selection of the best individuals for breeding purposes, the resultant offspring in each succeeding generation became genetically more and more pure or homozygous for the desired characters.

The early history of any pure breed invariably shows that resort was had to the same practice of close breeding and selection. The reason is obvious. The number of desirable animals is limited, and those favored with the qualities most sought for are used to the utmost in the formative period of the breed; and thus the offspring of the best foundation animals are used extensively to perpetuate the blood of the best. In-breeding is practiced in order to concentrate the qualities possessed by the leading animals of the breed. To test the truth of this statement it is only necessary to trace out the pedigrees of animals chosen at random to the early foundation stock and find how often the names of well recognized individuals appear.

Mendel's Law. Any intelligent discussion of the principles of animal breeding must be based on an understanding of the manner in which the mechanism of inheritance functions. The individual can only develop to the limit set by its inheritance; and perfect health, normal functioning of the vital organs, a favorable environment, and good training are the essentials required for the complete achievement of its inherent capacities. No individual can influence his heredity, for it comes to him from his ancestors through the fusion of the germ plasm of his parents.

As to knowledge of the mode of inheritance, we are indebted to the early discoveries of an Austrian monk, Johann Gregor Mendel, who experimented with garden peas, and by close study of the method of transmission of simple characters such as color and size, discovered the principles embodied in Mendel's Law. By crossing yellow and green peas he produced a hybrid yellow strain. When these hybrids were planted the resulting peas were green and yellow in the ratio of 1 to 3. All of these second generation green peas reproduced green, but two-thirds of the yellow of the second generation behaved the same as the yellow hybrids; while the remaining third of the yellows reproduced yellow.

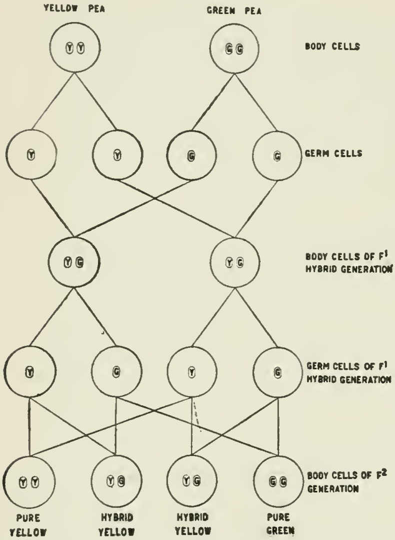


Fig. 39. Chart to illustrate Mendel's Law

Mendel's work was done with peas, but the principles he established apply to animals as well as plants.

In order to comprehend the workings of inheritance according to Mendel's Law, it is necessary to know something of the structure of the organism. All parts of the animal body are made up of cells, much the same as a house is built of bricks. The cells are packed closely together like rubber bags filled with water. Each of these cells contains a small body called the nucleus, which is the center of life and activity of the cell. There is contained within the nucleus of each cell a number of microscopic bodies called chromosomes. In the body cells these chromosomes are found in pairs, and there is a definite number of chromosomes in the cells of each particular species of organisms. For corn the number is twenty, wheat sixteen, man forty-eight, and so on through the entire animal and plant kingdoms. These chromosomes are made up of granular substance called chromatic material, the individual units or grains of which are chromomeres, and the number of these chromomeres in any cell may run up into thousands. A definite group of these elements or grains constitute each chromosome. The theory is that each chromomere is the determinant of a unit character in inheritance.

In the mechanism of inheritance we are dealing primarily with the germ cells, which are a group of cells specialized for reproduction, and it is one of these from each parent which unite to form the new individual. The mature germ cell of the male is called the sperm, and that of the female, the ovum or egg. In the formation of mature germ cells the number of chromosomes is reduced to one-half the number characteristic of the body cells of the species. To return to our example of the green and yellow peas, what happens in the crossing is represented diagrammatically by Fig. 39.

The factor for yellow is dominant over green, and consequently those individuals of mixed or hybrid makeup are yellow in color, but because of the presence of the recessive factor for green, the mating of such individuals results in one-fourth offspring pure green, one-fourth pure yellow, and one-half hybrid yellow, like the parents. In these hybrid peas both the factors for green and yellow color are present in the chromosomes, but because the factor for yellow is dominant over the recessive factor for green, the peas are yellow. Whenever this mixed, or heterozygous condition of factors for unit characters exists in the chromosome, the influence of the dominant factor determines the character of the organism.

This example of Mendelian inheritance deals only with a single unit character, but it serves to illustrate the working of the means whereby heritable characters pass from one generation to the next. All genetic studies are comparatively recent and in dealing with higher animals the inheritable complex is so vastly involved that the limited available knowledge does not yet afford much assistance to the breeder concerned with the problem of milk production. Most characters in animal inheritance depend on the presence of a number of units for their complete development, and this appears to be true of milk production and quality, or percentage of fat in milk, but our present meager information leads to the belief that these two characters are inherited independent of each other. The main point in this discussion is to bring out the fact that the factors pass on as units and are not blended in reproduction. As Sewell Weight[1] aptly states, "The union of sperm and ovum in its bearing on heredity may be compared to the mingling of two collections of solid beads instead of to a mixing of two liquids." A complete set of units is received from each parent.

Each individual possesses all the normal characters of the race to which he belongs, whether the characters are evident or not. In the higher races the characters are so numerous that not all of them can develop in any single individual, the proof of which is found in the fact that he will transmit to his offspring things which are not apparent in his makeup. While milk production is a function of the female, it is transmitted by the bull as well as by the cow. Recessive characters may be carried for several generations without external evidence, as they are concealed by their dominants, but by a recombination of the germ plasm of two individuals carrying the same recessive character, it may come to the surface.

Variation. In animal breeding it is impossible to mate individuals which are absolutely identical, and as a consequence variation is bound to occur. This absence of absolute uniformity is readily accounted for by the presence of thousands of factors in the germ plasm of every individual. Variability is the universal rule among living beings.

Variations are attributed to three general causes: somatic modification or changes in the body; germinal recombinations or a different assembling of the unit factors in the fusion of sperm and egg; and modifications of the germ plasm, called mutations.

The first of these causes is due to environmental influences which in no way affect the germ plasm, and consequently are not transmissible, since all inheritance comes through the germ plasm.

---

[1] Bulletin 905, U. S. Dept. Agr.

The second cause for variation occurs when animals of complex germinal makeup are mated, as many factors are carried through several generations as recessives, and by later combination they segregate and become evident. Careful study of the ancestry of both parents for evidence of the previous existence of a supposedly new character should reveal the cause of such variation.

Mutations in higher animals are very rare, and usually lack authentication.

Judicious selection has been the breeder's best aid in the improvement of livestock through the advantages gained by variation. Likewise, selection is the breeder's method of eliminating undesirable variations. The general increase in the productive capacity of the specialized dairy breeds can well be attributed to the established practice of selection, although the improvement in methods of feeding and handling is partly responsible for this advance. For permanent progress there must be consistent selection and mating of these animals which have demonstrated by performance that they carry the desired combination of germinal factors; but in practicing this selection it is well to go beyond the individuals in question to determine the character of the ancestry from which they spring, for inheritance comes not alone from the immediate parents, but is a combination of factors handed down from preceding generations. It is here that the use of pedigrees proves indispensable.

Why the Offspring of High-Producing Cows are Often Mediocre. It is frequently the case that high-record cows do not impress their ability on their offspring. This is usually a case of an exceptional combination of germinal factors in an individual which cannot be transmitted intact, and in the reblending of factors in reproduction some of the units are lost, and the ability of the descendants of the high producers resembles more closely the average productive capacity of the ancestry from which it sprung. The only animals which can transmit the high-producing ability with any certainty are those which are genetically pure or homozygous for all the factors which cause high production, and the mating of such individuals only insures a satisfactory combination.

Here we encounter the danger of overestimating the value of official records, for unless we are sure that the individual is pure or homozygous, the offspring from the high-record cow will prove a disappointment from the standpoint of maintaining high production. The use of proved bulls is the best procedure to follow in selecting herd sires, since the proof of germinal purity or prepotency is based on the performance of his offspring. Uniform excellence in a large number of progeny is a sure indication of the presence and purity of those factors necessary for high production in the germ plasm of the sire.

Effect of Environment. From the foregoing discussion it can readily be seen that environment plays no part in heredity. The influence of environment on the individual can only favor or inhibit the complete development and functioning of those characters which are inherited. No amount of training can develop speed in a draft horse, and nothing in the feeder's art can change the tendency of beef cows to lay on flesh to that of milk production.

Law of Ancestral Heredity. The relative contribution of each ancestor to the germinal makeup of the individual is shown in percentage in the skeleton pedigree (Fig. 40), made up according to Galton's Law.

The relative importance of the individual in the pedigree is clearly brought out by this diagram, and the farther back in the ancestry an animal is located, the less significant it is in heredity, because its contribution to the germinal makeup is greatly diminished and diluted. This emphasizes the fallacy of stressing the value of a pedigree with two or three well-known individuals in the fourth or fifth generation. Unless the desirable characters are brought down intact through succeeding generations by equally prepotent descendants, they are soon lost in the new combinations of factors; and the only possibility of their reappearance is in a fortunate recombination and segregation of the desirable traits.

Inheritance of Acquired Characters. Animals are subject to modification by the use or disuse of parts and by external con-

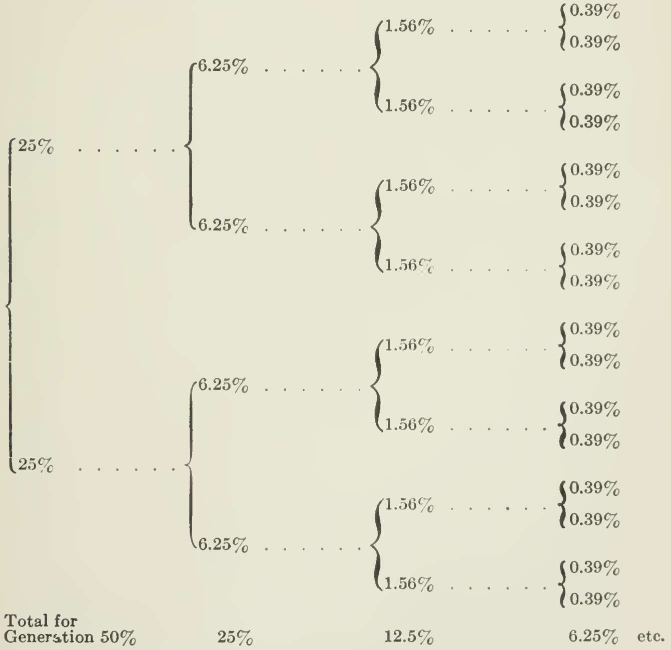


FIG. 40. Illustration of Galton's Law

This chart shows the relative importance of the ancestors in three generations. According to Galton too much stress is often given in cattle breeding to ancestors in the third or fourth generation back. This chart shows that each ancestor in the third generation contributes only 1.56 per cent to the total. The near ancestors are the ones that count.

ditions or environment, and it is natural to assume that a given species subjected to similar conditions of climate or food supply will all respond in much the same manner. This led to the popular belief that such modifications were transmitted from parent to offspring. Darwin has advanced the theory of pangenesis to substantiate this belief, claiming that the modified body cells exerted an influence on the germ plasm, thereby making the changes transmissible. Definite experiments carefully planned to test this theory have been inconclusive. Perhaps the most practical demonstration of its untenability is in the failure of the continuous docking of lambs to modify the length of the tails of sheep.

As the case stands today, there is no known means by which the body cells may modify the germ plasm, and the theories of continuity of germ plasm and germinal variation can account for all known facts of heredity. Any measure of control over heredity must be through selection of the parents and ancestors.

Sex Determination. The control of sex in offspring has been a subject of interest to breeders of domestic animals at all times, and theory after theory has been advanced for sex determination. None of the popular beliefs have stood the searching test of careful experimentation, and the best solution offered today for the problem of sex differentiation in cattle is the result of investigations by Wodsedalek[1]. The female cell carries a pair of sex-chromosomes, and consequently in the reduction process attending the formation of matured sex cells one chromosome passes to each ripened egg. On the other hand, the somatic or body cells of the male contain 36 ordinary and one sex-chromosome. In reduction, each alternate sperm receives a sex chromosome, and one of these uniting with the egg gives rise to a female; whereas the sperm without a sex-chromosome when combined with the egg produces a male, since it has the odd numbered condition. In conclusion Wodsedalek states that sex in cattle, for the present, remains a matter beyond the control of the breeder. It is determined by the sex-chromosomes; it is a matter of inheritance. He adds that there is no relation between the time in the heat period at which the cow is served and the sex of the offspring.

---

[1] Biological Bulletin, Vol. XXXVII, No. 5, May, 1920.

Relative Importance of Sire and Dam as Source of Dairy Qualities. All that has been said and written about Mendelian inheritance and the chromosome theory indicates that the male and female parent contribute equally to the total heritage of the offspring. This need not be interpreted as meaning that the parents are equal, nor that the influence of one parent which is germinally pure for certain dominant traits will not overshadow the less prepotent parent; yet it should be borne in mind that while the offspring of such a mating may manifest the characters of the prepotent parent, its germinal makeup may be mixed, or heterozygous, and many of the desirable qualities will fail to pass on to the next generation.

In ordinary practice the real difference between male and female is one of numbers of offspring. The females each give birth to a calf a year while the sire stands responsible for half the inheritance of all the calves. For this reason more care should be exercised in the choice of the head of the herd than the females. Without doubt the present practice of keeping most female calves, but discarding all bull calves except those from the better cows, is resulting in the popular belief that the bull's contribution to the offspring is greater than that of the dam; but as already stated, there is no scientific basis for this belief.

Prepotency. A prepotent animal is one which transmits its characters to its progeny no matter how mated. The only true test for prepotency is the test of offspring. One cannot judge from appearances whether or not an animal is prepotent; for even though he conforms to the ideal sought, his ability to transmit is in doubt until his progeny can be observed.

The ability of the prepotent individual to beget uniformly excellent offspring can be accounted for technically by the dominance of the factors back of these desirable characters and a homozygous or pure condition of these factors in the germ plasm. In the case of milk production, the question of prepotency is complex, as high production is dependent on a combination of favorable factors, and since chance still plays so large a part in obtaining this favorable combination, the scarcity of prepotent animals is patent. Careful selection and close study will in time increase the number of animals prepotent for high milk production. Rigidness of selection must apply no less to ancestors than to the present individual.

The Freemartin. The female of mixed twins in cattle is called a freemartin. It is a matter of common observation that such individuals are non-breeders; although there are isolated cases of freemartins which have successfully produced young. The bull calf of mixed cattle twins is a normal breeder. The proportion of normal females in such combinations is so small that it is not good practice economically to raise the freemartin unless she is from an exceptionally good dam.

The cause of this condition in female twins of mixed pairs is attributed to the action of hormones, a substance secreted into the circulating blood or lymph by the earlier developing sex organs of the male twin. The hormones inhibit the complete formation of the sex organs of the female.

The Pedigree. One meaning of the word pedigree is ancestry or lineage, and in this sense all animals have pedigrees. As used in animal breeding a pedigree is a list or table showing the ancestors of the animal in question and their relationship. For convenience the pedigree is generally put in a graphic form. The common practice is to use the bracket form as illustrated by Fig. 41. In this form of pedigree the name of the sire is placed at the top of each bracket and the dam at the bottom. In this pedigree of the Jersey bull Pogis 99th of Hood Farm the sire is Hood Farm Pogis 9th and the dam is Sophie 19th of Hood Farm. In the second generation four animals appear, the grandparents of the bull whose pedigree is presented. The term pedigree really includes only the record of ancestors but

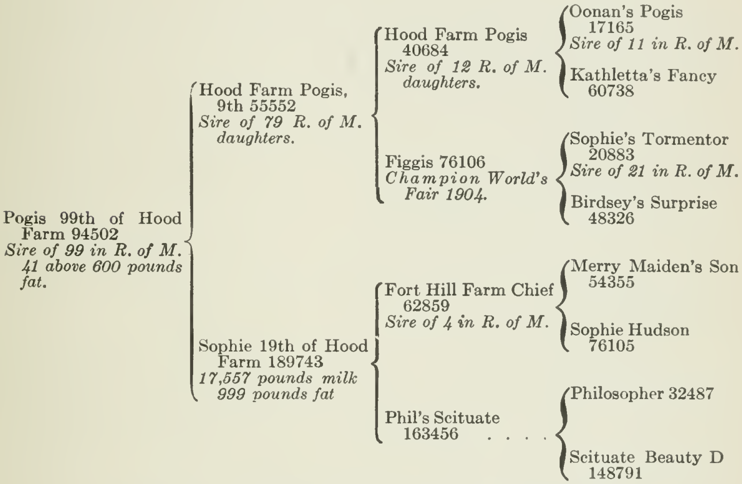

Pogis 99th of Hood Farm 94502
Sire of 99 in R. of M. 41 above 600 pounds fat.
Hood Farm Pogis, 9th 55552
Sire of 79 R. of M. daughters.
Sophie 19th of Hood Farm 189743
17,557 pounds milk 999 pounds fat
Hood Farm Pogis 40684
Sire of 12 R. of M. daughters.
Figgis 76106
Champion World's Fair 1904.
Fort Hill Farm Chief 62859
Sire of 4 in R. of M.
Phil's Scituate 163456 . . . .
Oonan's Pogis 17165
Sire of 11 in R. of M.
Kathletta's Fancy 60738
Sophie's Tormentor 20883
Sire of 21 in R. of M.
Birdsey's Surprise 48326
Merry Maiden's Son 54355
Sophie Hudson 76105
Philosopher 32487
Scituate Beauty D 148791

FIG. 41. Pedigree of Pogis 99th of Hood Farm 94502

This is the common way of showing the ancestors of an animal in graphic form. The name of the sire is at the top, that of the dam at the bottom of the bracket. The Advanced Registry records are shown below the name of the animal.

since official records of milk and fat products have become such important factors in the selection of breeding stock these records are usually thought of as part of the pedigree and are written in the proper position below the name of the animal concerned. In Fig. 41, for example, it is noted that Pogis 99th of Hood Farm is the sire of cows in the Register of Merit. These official records are given in as much detail as is considered desirable for the purpose for which they are to be used.

In-Breeding. In-breeding is the term applied to the practice of mating closely related individuals such as brother to sister, sire to daughter, or son to dam. To generalize a bit, an individual may be said to be in-bred when its parents show fifty per cent or more common ancestry in their pedigrees. While the term is used by geneticists, biologists, and practical breeders, it might be well to state that nothing so extreme as the in-breeding of laboratory animals and plants by mating full brother and sister for generation after generation has ever been attempted in the realm of practical animal breeding.

Langwater Cavalier	Sire: Dolly Dimple's May King of Langwater.	Imp. King of the May	Imp. May Rose King.
			Imp. Itchen Daisy 3d
		Dolly Dimple . . .	Imp. Yoeman
			Dolly Bloom
	Dam: Langwater Daisy .	Imp. King of the May	Imp. May Rose King.
			Imp. Itchen Daisy 3d
		Imp. Melamie of Goodnestone 3d .	Suzerain
			Imp. Melamie of Goodnestone

FIG. 42. Pedigree of Langwater Cavalier

This pedigree illustrates in-breeding. His sire and dam were half brother and sister.

Some of the advantages of in-breeding have already been referred to in the discussion of the early development of Shorthorn cattle. The primary effect of in-breeding is to intensify or fix hereditary qualities and thereby bring about prepotency for certain characters. It is not surprising therefore that the fixation of type in the early establishment of any breed is best accomplished by in-breeding. Once this purity of germinal makeup is accomplished, its transmission to offspring is almost certain, as in the case of the white faces of Hereford cattle.

The same mechanism which makes in-breeding so successful in fixing desired characters is working just as constantly to bring about the concentration of factors in the germ plasm which may lead to disaster. The things most feared in this connection are decreased fertility and vigor. Fertility is a character of prime importance to breeders of domestic animals, and any successful demonstration of the advantageous use of in-breeding is apt to be closely scrutinized by the practical breeder for evidences of lowered vitality and lessened fertility in the offspring. Perhaps the best known case of the ill effects following close in-breeding is found in the high percentage of non-breeders among the Bates' Duchess Shorthorns. Investigation shows that this strain carried barrenness very early in the family history and there was no greater intensification of this defect than would follow in any other character where in-breeding is employed. Mumford[1] reports cases of long continued in-breeding of both dogs and of Berkshire hogs without loss of vigor or fertility. Wright[2] observed the results of maintaining families of guinea pigs wholly by matings of brother and sister. Some families declined in vigor, but one has reached the twentieth generation with no evident loss of vigor. He concludes that in-breeding is merely likely to lead to decline in vigor. but does not necessarily do so. After long continued in-breeding of fruit flies, Castle and his associates concluded that in-breeding unaccompanied by selection generally results in decreased productiveness, but that proper selection for high productiveness results in maintaining the original fertility of the race. Careful selection of individuals from large litters of white rats has resulted in increasing the average size of litters by in-breeding.

With all the evidence at hand it can be safely concluded that danger lurks in the use of in-breeding by anyone but a breeder who is capable of selecting his breeding animals not alone for the presence of desirable factors he is seeking to concentrate, but as well for the absence of those things which will in the end lower vitality or lessen fertility. It is the most rapid means of advancement in breeding, but is a dangerous tool in the hands of any but those trained to its use.

---

[1] *The Breeding of Animals*, p. 228 (1917). [2] Bulletin 905, U. S. Dept. Agr.

Line-Breeding. The mating of animals related in a lesser degree than that described as in-breeding is known as line-breeding. Where the common ancestry of the parents ranges from 25 to 50 per cent we have what is popularly called line-breeding. This system is said to possess all the excellencies of in-breeding with a greatly lessened tendency toward production of defectives.

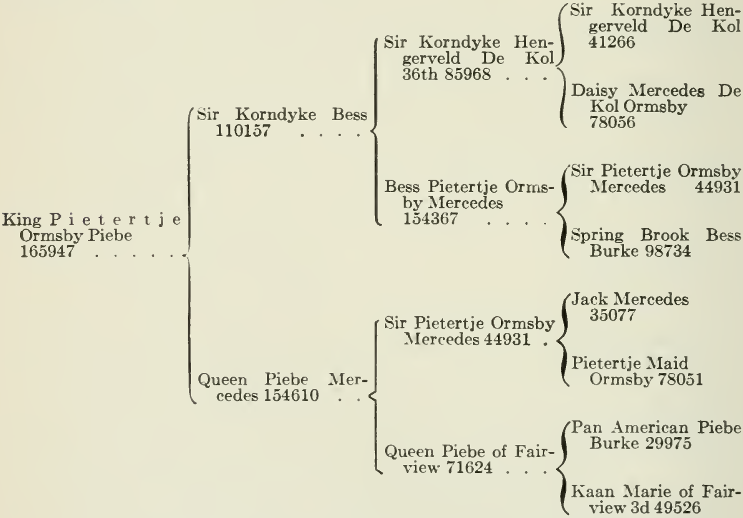

King Pietertje Ormsby Piebe 165947 . . . . . .
Sir Korndyke Bess 110157 . . . .
Queen Piebe Mercedes 154610 . .
Sir Korndyke Hengerveld De Kol 36th 85968 . . .
Bess Pietertje Ormsby Mercedes 154367 . . . .
Sir Pietertje Ormsby Mercedes 44931 .
Queen Piebe of Fairview 71624 . . .
Sir Korndyke Hengerveld De Kol 41266
Daisy Mercedes De Kol Ormsby 78056
Sir Pietertje Ormsby Mercedes 44931
Spring Brook Bess Burke 98734
Jack Mercedes 35077
Pietertje Maid Ormsby 78051
Pan American Piebe Burke 29975
Kaan Marie of Fairview 3d 49526

FIG. 43. Pedigree of King Pietertje Ormsby Piebe

This pedigree illustrates line-breeding. His sire is a grandson of Sir Pietertje Ormsby Mercedes and his dam a daughter of the same bull. The breeder practices line-breeding for the purpose of retaining a larger percentage of the blood of a great transmitting ancestor.

Line-breeding is without doubt the most popular system of breeding, particularly in breeds such as Jersey cattle, where definite families have been long established. Much progress in cattle breeding is traceable to line-breeding, as many men have held aloof from in-breeding for fear of disaster; but they have recognized the principle of concentration of desirable characters through the use of related animals and hence have resorted to line-breeding. Results this way may come more slowly, as there is constant introduction of hereditary elements from slightly different lines of descent. But while this may retard the purifying process for desirable characters, it also serves to neutralize defective elements, and in this we may find the cause for the popularity of line-breeding, as most men would prefer to progress slowly in animal breeding rather than to follow short cuts where possible disaster lurks.

One danger which is ever present in line-breeding is the possibility of selection entirely by pedigree, and the abandonment of individual selection. While the pedigree may picture an ideal combination of ancestry, any system of progressive breeding must be based on the mating of superior individuals.

Out-crossing. Mating of entirely unrelated individuals, or those of less than 25 per cent common ancestry, is commonly called out-crossing. In breeds where families or strains have become well established, such practice is usually avoided. While it is undoubtedly true that the greatest success of some well-known breeders is founded on the use of a great bull which was unrelated to the females to which he was bred, it is rare indeed that such a breeder fails to change his practice to line-breeding after this initial outcross, principally in order to concentrate and perpetuate the blood of his great sire. Once he becomes an advocate of line-breeding, he has tied himself to a certain strain or family and draws back instinctively from the utilization of animals unrelated to his own.

There is no authentic backing for much of the adverse criticism of out-crossing in cattle breeding, and close study may reveal unusual advances made by the mating of distantly related or unrelated individuals.

Nicking. The practice of line-breeding by many cattle breeders has resulted in the growth of a so-called nicking theory. It is based on observation, and the theory is that individuals of certain strains within the breed, when mated, produce highly desirable offspring; whereas other combinations fail to "nick" and are not looked upon as successful. This is another popular belief which cannot be borne out by scientific principles. Within a certain breed the factors for high milk production are the same, and if they are carried pure in the germ plasm of both male and female, there is nothing which will prevent their transmission to the offspring regardless of the families to which the parents belong. In other words, if both cow and bull are prepotent for high production, the descendants of such a cross are bound to be high producers. The nicking theory fails to stand up when applied to other Mendelian characters which are known to be dominant, and when two Herefords are mated the offspring will have Hereford markings regardless of family, and we know these markings are heritable as is also milk production.

The Value of a Pedigree. The sample pedigrees shown here serve to illustrate the three recognized systems of breeding, and each of the individuals has proved to be a prepotent sire. This indicates clearly that the combination of factors necessary for the transmission of high production may be secured by either in-breeding, line-breeding, or out-crossing, and no one system has a monopoly in the production of prepotent animals. Pogis 99th of Hood Farm is the result of an out-cross, as there is no common blood in the ancestry of his sire and dam. Langwater Cavalier (Fig. 42) receives an infusion of the blood of Imp. King of the May through both his sire and dam, and he is classed as an in-bred bull. King Pietertje Ormsby Pietje has a common ancestor on both sides in Sir Pietertie Ormsby Mercedes, constituting 37½ per cent, and making him a line-bred bull according to the general classification.

The pedigree is a graphic representation of the ancestry of the animals. It shows the animals from which the individual draws its inheritance, and by the use of the outline on page 219 the relative contribution of each ancestor to the sum total of the inheritance may be calculated. Each of the sixteen ancestors in the fourth generation is responsible for less than one-half of 1 per cent of the total, and unless an animal appears a number of times that far back, his influence is negligible. The parents contribute half of the total and should receive consideration corresponding to their importance in making the individual selection.

Attention has already been called to the danger of relying entirely on selection by pedigree without regard for individual excellence.

The use of the pedigree is resorted to extensively in selling cattle, and this has led to abuse in the preparation of pedigrees. As every handler of pure-bred cattle knows, values are largely based on records of performance. These records are shown in red ink beneath the names of the animals concerned. In order to build up the production story in a pedigree, resort is often had to entering records of distantly related animals. As an example we may find a statement that a young bull is sired by a son of a half-brother to some cow with a large record, or that his dam is a half-sister to the sire of a great bull. In either case the animal with the record will not be found in the pedigree under consideration. This subterfuge is easily detected by a careful reading of the red ink in the pedigree, and it is a safe rule to ignore all statements except those which bear directly on the animals listed in the pedigree. At a public auction, close analysis is not possible when animals are sold quickly, but the wise buyer secures a catalogue in advance, studies the pedigrees at his leisure, and then confirms his selection by inspecting the animals at the sale before they are brought into the ring.

Crossing Breeds. The development of a modern breed of dairy cattle is the result of a long continued process of selection of individuals showing characters sought by the breeder. By this method the desired characters have become fixed, and the selective process has resulted in purifying the germ plasm, thus insuring a degree of certainty in the transmission of the desired traits when individuals of the same breed are mated. By crossing distinct breeds we interfere with this transmission of the factors and combinations of factors which account for the distinctive characters of the individual breeds. The result is not an exact blending of the characters of the two breeds, but an entirely new combination of factors and units, which may result in the loss of most of the valuable traits of each parent. It is likewise true that the offspring of such a cross may prove desirable in many respects, but from a standpoint of breeding these crossbred animals are an unknown quantity, since they carry in their germinal makeup a mixture of the factors of two separate breeds, and how these will segregate out on recombination is most uncertain. That many of the second generation individuals will prove unsatisfactory seems assured, for this practice is mainly a repetition of the steps followed in the early development of any breed, when close culling was essential. As a rule, little is gained, and the outcome often is very disastrous. However, it is a very common practice with many. A farmer having perhaps a good grade herd of Jerseys observes the much larger yield of milk secured by his neighbor who breeds Holsteins and decides to make a Holstein cross, thinking he will combine the quality of the Jersey with the quantity of the Holstein. Occasionally this end is partially attained, but just as often the animal inherits the quantity of the Jersey and the quality of the Holstein. The next year the farmer possibly decides his animals are too small, and uses a Shorthorn to increase the size. The result of such practice is to lose the breed characters, and the occasional good animal that appears from such a mixture does not transmit any definite characteristics.

It is a well-known fact that as a rule in crossing breeds of animals for market, such as hogs or beef cattle, the first cross between distinct breeds is good, and some animals may have the good characteristics of both breeds to some extent. But herein lies the danger of cross-breeding, as the excellence of these individuals may tempt the breeder to use them as breeding stock. The proper course to pursue is to first select the breed, after due consideration, that seems to meet the requirements or tastes of the breeder, then select the best individuals and the ones most likely to transmit these characters from this breed, and continue along the same line unless it is found after sufficient trial that a serious mistake has been made.

Value of Testing. In order to measure progress in breeding work it is necessary to have some standard of excellence by which to compare individuals of succeeding generations. In this respect the breeder of dairy cattle is fortunate, as the comparative producing ability of mother and daughter afford him an unquestioned measure of the degree of progress or decline he is able to accomplish. To make this comparison as accurate as possible, the conditions under which his cattle are tested must be uniform, and due allowance should be made for differences in the ages of daughter and dam. Herein lies perhaps the greatest value of cow testing, as it is a far more accurate measure of ability than any estimate which can be made from observation of conformation or type, and the results of testing are unerring in detecting those individuals which may appeal to the eye but fall down miserably in performance at the pail.

Cow testing can hardly be overemphasized, for in addition to aiding the breeder in his work, it enables the dairy farmer to cull his herd and eliminate cows which fail to pay for their keep, and it assists him in building up the productive capacity of his herd by selecting heifers from his best cows. In addition, the test is the sure way of locating the prepotent sire. It also adds great value to pure-bred animals, as purchases are largely based nowadays on official records, and there is a direct correlation between high and low records and prices as established in public sales.

For the man who is handling pure-breds, official testing is almost indispensable. The cost of this work will be returned many times over in the price realized for the stock he has to sell Full details of official testing are given in another chapter.

Smaller breeders and dairy farmers will reap a great benefit by joining cow-test associations. This will give them a true index of the ability of the various cows in the herd, and it often adds materially to the value of such animals as show more than average ability. Carefully and regularly conducted private tests will serve much the same purpose as the association work, but it has already been pointed out that too many other things are allowed to interfere with private testing which detract greatly from its efficiency. Furthermore, cow-test association records are receiving more and more recognition by the purchasing public.

Bull Associations. There is still another movement on foot for the improvement of dairy herds by the use of better sires. The value of a good bull is fully appreciated, and his extensive influence in the herd is recognized; but many dairy farmers are deterred from purchasing a pure-bred bull because the number of females they keep is too limited to warrant the expense. To overcome this obstacle, bull associations are being organized, and the movement had its beginning in the state of Michigan in 1908. These are community organizations, and a number of dairy farmers agree to purchase one or more pure-bred bulls of recognized breeding ability for use jointly in their herds. Where the association is large, the farmers are grouped in blocks, and one bull placed in each block. At intervals of about two years these bulls are moved from block to block, in order to avoid breeding them to their own daughters. The movement made slow progress at first, and in 1918 there were only 44 such associations; but since that time the advance has been more rapid, and in July, 1921 there were 158 associations in existence throughout the country. The work of organization is carried on jointly by the Dairy Division of the United States Department of Agriculture and the State Extension Service.

The advantages of the pure-bred bull association are obvious. First of all it permits the pooling of resources of a number of farmers in the purchase of a bull, enabling them to pay better prices and secure correspondingly better sires. These bulls have a larger opportunity to demonstrate their worth, as they are bred to more cows than if they were used in a single small herd. The bulls are also kept in service for a longer period of time, and those that prove prepotent can be retained in the community until old age ends their usefulness. Like all other coöperative movements, the bull association creates a greater interest in the breeding of stock, and it often results in the development of dairying as a community enterprise. It also arouses enthusiasm for better cattle, and the introduction of several good pure-bred bulls into a county may be followed later on by pure-bred females in many of the herds.

Why So Few Pure-bred Bulls? Innumerable instances are on record and countless stories have been written of the rapid improvement in dairy cattle through the use of pure-bred bulls, and the question naturally arises why so few pure-bred bulls are in use. Records of pure-bred cattle associations show that less than half as many males as females are registered. This is due partly to closer culling of bulls; but if all the pure-bred bulls dropped were kept for service to replace scrub sires, there would not be nearly enough to go around. One fact that contributes to this condition is the small size of many herds kept by dairy farmers, but this can be overcome by the organization of bull associations, or the coöperative purchase of a good bull by two or more farmers in one neighborhood. Another factor entering into the problem is the poor salesmanship on the part of breeders of pure-bred stock. Many of them ignore this large field for disposing of their bulls, and limit their selling efforts to herds of pedigreed stock. While it is true that better prices are usually realized from the latter class of buyers, it is also true that their demands are more exacting, and every herd has a surplus of males that could well be placed in grade herds at a fair profit to the breeder.

Summary. As a summary to this chapter on cattle breeding the following recommendations are made to the breeder of pure-bred dairy cattle:

Use proved sires whenever possible, as the progress of years may all be lost by bringing an untried bull into the herd.

Cull the female herd carefully and constantly, in order to eliminate undesirable individuals and prevent the perpetuation of their qualities through offspring.

Test the cows and heifers in order to determine what progress is being made and to measure the transmitting ability of both the herd sire and females.

For the dairy farmer with a grade or scrub herd it is recommended that he:

Join a cow-testing association in order to determine the truth about the productive ability of each member of the herd.

Cull the female herd according to the results secured by testing.

Send the scrub sire to the butcher and replace him with a pure-bred of the breed best adapted to local conditions. If the herd is too small to warrant the purchase of a pure-bred bull, start a movement for the organization of a bull association, or buy a good bull jointly with one or two neighbors.

CHAPTER XVI

CALF RAISING

Economic Considerations. According to the 1920 census report there were at that time approximately 23,000,000 cows used for dairy purposes in the United States. It has been found that cows are milked on the average of not more than five years each, which means that they are replaced when not more than eight years old. On this basis 4,600,000 heifer calves must be raised each year to maintain the number of dairy cows in use in the United States in 1920.

The individual dairyman who raises heifers to replace his discarded cows finds it necessary to retain at least three heifer calves yearly for each ten cows in the herd in order to be safeguarded against loss of calves by death and to replace cows that may be eliminated on account of inferior dairy qualities.

It is estimated by the Bureau of Markets that in addition to the skim milk used, 3.5 billion pounds, or 4 per cent of the whole milk produced in the United States, is used for calf raising.

Importance in Maintaining the Herd. The success of the dairy farmer depends to no slight extent upon the careful rearing of the calves. The careful dairyman sees in every heifer calf the possibility of a cow that will not only replace a discarded member of his herd, but help to raise the average production. By proper care in the choice of the sire, and by careful attention to the rearing of the calves, the dairyman who is compelled to start with a herd of ordinary quality may, within a few years, raise the average production of his herd to a marked extent. On the other hand, carelessness in breeding and in calf-raising is bound to result disastrously to a herd or, at least, to keep it at a standstill as far as improvement is concerned.

One of the common mistakes made in the localities where whole milk is sold for market purposes or to condenseries or cheese factories is the failure to raise any calves. In this case the milk producer depends upon buying cows to replace those discarded from his herd. The excuse for this practice is that the cost of raising cows is too great. Under such a system a dairyman will almost invariably produce milk year after year without improving the standard of his herd in the least. When more cows are required, they are purchased from a shipper or dealer, and without any information available regarding the merits of the animals beyond what can be determined from appearance. The dairy cows placed on the market through such channels are almost certain to be of very ordinary grade, since a cow whose value as a milk-producer is known is not offered for sale at the market price. The practice of replacing cows by purchase also involves the danger of introducing such diseases as tuberculosis and contagious abortion, which may result in the destruction of the entire herd.

In a few localities the practice is even worse, inasmuch as the cows are purchased when about to calve, and are milked but a single milking period, and are then fattened when the milk flow slackens, and sold for beef. In this way the general average of production is exceedingly low, and the occasional good cow is not even saved for future usefulness. The author has known herds, in which the discarded cows were replaced by purchase rather than by raising calves, to be maintained for over twenty years without the slightest increase in the average production. The only means by which the average quality of dairy herds in the hands of practical dairymen can be materially improved is by the raising of their own cows by using a pure-bred sire and saving the heifers from the best cows.

Birth Weight of Calves. Table 24 gives all the available data on the weight of calves at birth.

TABLE 24. BIRTH WEIGHT OF CALVES

BREED	MALES		FEMALES		AV. BOTH SEXES		WEIGHT OF CALF IN PROPORTION TO WEIGHT OF DAM PER CENT
	NO.	LBS.	NO.	LBS.	NO.	LBS.	
Jersey	102	58	94	53	253	55	6.3
Holstein	69	93	85	88	229	89	7.8
Guernsey					57	71	7.1
Ayrshire	27	73	26	65	80	72	7.3
Brown Swiss					5	100	8.9
Dairy Shorthorn	11	74	19	73	30	73	6.0

This table shows the males average heavier than the females at birth. The Brown Swiss and the Holstein calves are the largest at birth, and are also heavier in proportion to the weight of their dams.

About three out of five calves come within 10 per cent of the average weight. Breed is the most important factor influencing the size. The maturity of the cow also has some effect as shown in Table 25.

TABLE 25. INFLUENCE OF AGE OF DAM UPON WEIGHT OF CALF AT BIRTH

	JERSEYS		HOLSTEINS	
	NO. OF CALVES	AVERAGE WEIGHT LBS.	NO. OF CALVES	AVERAGE WEIGHT LBS.
First calf	44	51	45	85
Second calf	35	55	31	88
All subsequent calves	116	57	79	95

There is a tendency for cows of advanced age to produce calves rather smaller than those from cows in the prime of life. Length of the gestation period is not correlated with the size of the calf at birth except in cases of extremely large or small calves. The sire has no apparent influence on the birth weight except in cases of cross-breeding.

The size and vigor of the calf at birth is not influenced as much as might be expected by the previous feeding and condition of the dam, unless her ration is restricted unduly, as in limiting it to the products of a single plant, or where the quality of the proteins or the mineral complex in the feeds offered is deficient. This is not apt to occur in ordinary farm practice. The reproductive function is so strong that in case of insufficient feed the fetus draws on the mother's body, and it is the mother that suffers mostly from the deficiency in nourishment. On the other hand, when a cow is excessively fat, the calf in many cases is somewhat under-sized.

Raising Calves by Hand. The dairy calf is almost always reared by hand, although a very small portion of the milk that goes to make the total production of the country is from cows whose calves are allowed to take a portion of the milk from their mothers. As a rule, the milk of the dairy cow is worth so much more than the calf that it receives the first consideration. The question of calf-raising is naturally divided into two parts. One deals with calf-raising where skim milk is available—as is generally the case when cream or butter is sold. The second part is concerned with methods of raising the calf where the whole milk is sold for market purposes or to a condensery or cheese factory. In this case no skim milk is usually on hand, and the calf must be fed whole milk, which makes an expensive ration, or it must be given some substitute for milk.

Raising Calves on Skim Milk. It is a well-established fact that a calf can be raised on skim milk that is equally as good as one nursed by its mother. In localities familiar with dairying this is well understood, but in other places is virtually unknown. Some have seen unhealthy and under-sized calves that have been fed skim milk, and have considered them as the necessary result of feeding skim milk. Such calves are the unfortunate victims of their owners' ignorance or carelessness. The skim milk calf raised according to modern methods differs little, if any, in size, quality, and thrift and value from the same animal when raised by the cow. The poor results which have so often followed the feeding of skim milk have been due to the faulty methods, and not to the fact that the cream which has been taken out is absolutely indispensable to the normal development of the calf.

The following statement gives the average composition of whole milk and separator skim milk:

	WHOLE MILK	SKIM MILK
Water, per cent	87.10	90.50
Fat, per cent	3.90	.10
Proteids, per cent	3.40	3.57
Sugar, per cent	4.75	4.95
Ash, per cent	.75	.78

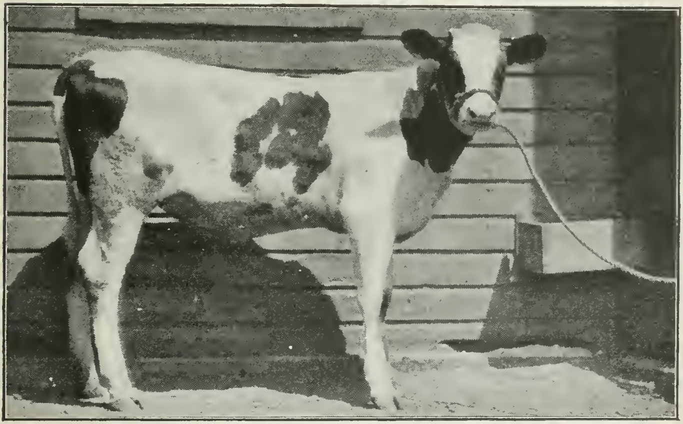


FIG. 44. A calf six months old raised on skim milk. This calf has made a growth somewhat above normal on a ration of skim milk with the usual grain and hay supplements. Daily gain from birth 1.5 pounds.

It will be observed that the skim milk differs from the whole milk only in having most of the fat removed. The other constituents are slightly increased. The butter fat or cream is by no means the most valuable part of the milk for the calf. The fat does not serve primarily to support growth in the young animal, but to keep up the heat of the body and to supply fat for body tissue. Material which serves these purposes can be supplied much cheaper in the form of carbohydrates in corn meal or other grain. Milk fat is one of the carriers of the fat soluble vitamine or growth accessory, but fortunately this essential substance is also present in the leafy portions of many forage plants and can be supplied to the animal in the roughage portion of the ration. The raising of the calf on skim milk is economical, because it is possible to make this substitution of a comparatively cheap grain for butter fat, which has a commercial value for human food out of proportion to its food value for a calf. The protein of the milk is of special importance in relation to growth. The casein and albumin which together make up the protein are of especially high quality and more efficient for growth than proteins from grains. From the protein is made muscles and bone, nerves, hair, and hoofs; and this protein remains in the skim milk. The calf fed on skim milk is not generally so fat during the first six months of its life as the one nursed by the cow. It often has, however, rather a better development of bone and muscle, and the difference between the two cannot be seen two weeks after weaning time. At Storrs Experiment Station it was found that two calves fed on milk testing 3.27 per cent, one for 63 and the other for 30 days, consumed 1.16 and .91 pounds of milk solids respectively for each pound of gain in weight, whereas two calves fed milk testing 5.1 per cent and 4.6 per cent for 53 and 30 days required 1.33 and 1.03 pounds of milk solids respectively for each pound gained. The results clearly show larger daily gains on a smaller amount of solids per pound for the calves which received the milk containing the lower per cent of fat.

The practice of raising calves on skim milk, supplemented with mixtures of farm-grown grains and legume hay, has been well established for a number of years, and the data available resulted from experiments conducted during the investigational period. The figures shown in Table 26 afford an accurate record of the quantities of milk, grain and hay used in successful trials.

TABLE 26. FEED REQUIRED FOR SKIM MILK CALF THE FIRST 180 DAYS

	STORRS[1] EXP. STA.	STORRS[2] EXP. STA.	PURDUE[3] EXP. STA.	NEB.[4] EXP. STA.	MISSOURI[5] EXP. STA.
No. animals	3	17	10	16	4
Length of period, days . .	180	180	182	168	
Whole milk, lbs.	73	155	131	242	367
Skim milk, lbs.	2,067	2,954	2,022	2,450	3,041
Hay, lbs.	277	477	456	80	81
Grain, lbs.	231	63	179	128	90
Pasture, days	—	—	—	98	90
Weight at beginning, lbs. .	75	62	62	68	73
Weight at end, lbs.	299	299	283	299	329
Average gain per day, lbs. .	1.25	1.28	1.21	1.37	1.41

[1] Storrs Exp. Station Bul. 102 (1919).
[2] Storrs Exp. Station Bul. 28 (1904).
[3] Purdue Exp. Station Bul. 193 (1916).
[4] Nebraska Exp. Station Bul. 83 (1905).
[5] Unpublished data.

The above table shows that the calf can get along with as little as 73 pounds of whole milk, although generally 200 pounds or more are fed. The skim milk varies as a rule between 2,000 and 3,000 pounds and, while calves can be reared without grain when skim milk is fed, it is customary to feed up to 150 pounds per animal during the first six months. These figures vary according to the thrift of the animals and skill of the feeder, but satisfactory results can be had by feeding quantities within the limits shown in the table. The calves receiving a larger amount of whole milk weigh heavier at the close of the milk feeding period, but this difference gradually disappears during the next few months if all the animals are fed alike.

Fall calves need from 300 to 600 pounds of hay the first six months, depending upon how much other feed is given. Spring calves may be put on pasture and given no hay, or they grow equally well if kept confined for the first three or four months and fed hay.

Comparisons of Whole Milk and Skim Milk Calves. Table 27 gives data reported by Otis[1], showing the comparative gains made by three lots of ten calves each, fed on skim milk, on whole milk, and nursed by the dam.

TABLE 27. COMPARISON OF RESULTS. CALVES RAISED BY HAND, AND NURSED BY DAMS

EXPERIMENT	NUMBER OF CALVES	DAYS FED	AVERAGE GAIN PER HEAD	DAILY GAIN PER HEAD	COST PER 100 LBS. GAIN
Skim Milk	10	154	233	1.51	$2.26
Whole Milk	10	154	287	1.86	7.06
Running with dams .	22	140	248	1.77	4.41

The cost of a hundred pounds of gain as given is low on account of the very low scale of prices for feed and butter fat current at the time the data were taken. The value of the comparison, however, is not affected. The calves nursed by the dams and those fed whole milk made a slightly better gain than those fed skim milk; but it was at a much greater expense, as shown in the table. The skim milk calves consumed 122 pounds of grain per 100 pounds gain, while the whole milk calves consumed 58 pounds grain and 31.8 pounds of fat in the milk. At this rate 100 pounds of grain were equivalent in feeding value to 48 pounds of fat. The economy of substituting the butter fat by grain is apparent, since the market value of butter fat is usually from twenty to thirty times that of corn meal fed to supplement skim milk. In the experiment quoted the calves which were steers were later put in the feed lot, and all fed for seventh months. The best gains were made by the skim milk lot, followed by the whole milk lot, while the lot raised by dams stood last.

---

[1] Bulletin 126, Kansas Experiment Station (1904).

Taking the Calf from its Mother. There is some difference in practice regarding the time of beginning hand feeding. Some take the calf away from its mother at once, without allowing it to nurse at all. Others prefer to let it nurse once; and some allow it to remain with the cow three or four days, or until the fever is out of the udder and the milk is fit for use in the dairy. It probably makes very little difference as to this point; but it is a fact easily established that the earlier the calf is taken from the cow, the easier it will be to teach it to drink. The calf that has never nursed is easily taught to take the milk from a pail, while one a week or a month old is often a difficult subject to teach. A safe practice and one generally followed is to take the calf away from its dam on the third day. When the udder is caked it is best to leave the calf with her until this condition is removed. One point that must be kept in mind is that at first the milk from the mother should always be given the calf, and not milk from some other cow. The first milk, or colostrum, given by a cow is especially suited to the requirements of a young calf. The usual explanation has been that the colostrum acts as a physic and stimulates the digestive organs. Recently it has been found by one investigator that two proteins of the blood which are absent in the new-born are present following the ingestion of colostrum.

Recent investigations by Smith and Little further emphasize the importance of the colostrum milk to the new born calf and give a new explanation of its value. In their experiments all of ten calves allowed to take colostrum survived, while eight out of twelve which did not get colostrum died, and one other did not thrive. Their explanation is that calves deprived of the colostrum lack something which permits intestinal bacteria to invade the body and multiply in the various organs. In most cases a rapidly fatal septicemia is the result. The calves which do survive are able to resist the invading bacteria and develop into normal animals, or in some cases the joints or kidneys may be affected. According to the view of the investigators the function of the colostrum is to serve as a protection against miscellaneous bacteria which are harmless when the protective functions of the calf have begun to operate.

Amount of Milk to Feed. Under natural conditions the calf takes its milk frequently and in small quantities. The calf's stomach at this time is not suited for holding a large amount, and an excessive amount always results in indigestion or scours. For this reason it is well to feed the young animal three times daily for a week or two. It is an easy matter to teach a calf to drink milk from a pail. Omit the first regular feeding period after the calf is removed from its dam and it will be eager and hungry. Then offer it a small amount of milk in a pail and gently lower its head until the muzzle is in the milk, by allowing the calf to suck the feeder's fingers, drawing its head down into the bucket, and withdrawing the fingers when it tastes the milk. For the first week, 4 or 5 quarts, or about 8 or 10 pounds per day, is all the largest calf should be allowed to take. A small calf, as a Jersey, does not need over six or eight pounds per day on the start. The second week these amounts can be raised a pound or two, provided the calf has shown no sign of indigestion and its appetite is good. As the calf grows older, somewhat more milk can be used, but at no time does it need over 16 or 18 pounds, or eight or nine quarts per day; but it is safe and economical to feed as high as 20 pounds to a large calf if skim milk is plentiful. Over-feeding is undoubtedly one of the most common causes of inferior calves. It is a mistake to think that because the cream has been removed, the calf needs more of the skim milk, or that because the calf is not doing well it is not getting enough milk, and to allow it to gorge itself, which it will readily do, if given an opportunity. A good rule is always to keep the calf a little hungry. Some provision must be made for making certain that each animal gets its share and no more. Some drink twice as fast as others; and if fed together, one will be overfed and the other starved. The plan sometimes used of feeding a bunch of calves together in a trough is very unsatisfactory for this reason, and should never be followed. Success can only be assured by individual feeding.

Temperature of the Milk. Another precaution that should be taken is to have the milk warm and sweet when fed. Nature furnishes the milk to the calf in this condition, and we must carefully imitate her here. The digestion of a calf is quickly upset by feeding warm milk at one feed and cold milk at another. For the first few weeks the calf is especially sensitive to the temperature of its feed. After it is three months or more old, the milk may be fed somewhat cooler, if care be taken to have it at the same temperature all the time. Even then, however, the best results are secured when the milk is fed warm. The temperature of the milk should be that of the blood, or approximately 100° F. In this matter the feeder should exercise great care and not go by guess or by the feeling of the milk, but should actually use a thermometer often enough to know what blood heat feels like. If a hand separator is used, the milk may possibly be fed while still warm enough if used immediately after separation, but it will usually be necessary to heat it artificially, if used for young calves during cold weather.

Changing to Skim Milk. For the first two or three weeks the calf should be fed part of its mother's milk. However, in raising calves of those breeds producing a very rich milk, the calf will often thrive better if the whole milk given during the first two or three weeks be diluted with some skim milk. Beginning at the age of two weeks, if the calf is doing well, the ration may be gradually changed to a skim milk ration by putting in a small amount of skim milk at first, and gradually increasing the amount day by day until at the end of a week all the whole milk has been replaced.

Supplements to Skim Milk. The calf should be taught to eat grain as soon as it will take it. This it will generally do by the time it is three weeks, or, at most a month, old. The grain is best fed dry after feeding the milk. If the calf is with others, it will when large enough generally learn from them to eat. When the calf does not begin to eat grain as early as it should, it can be taught to do so by putting a little grain in its mouth after the milk is drunk. In a few days it will begin to look for the meal, and will eat it, if offered in a box within reach.

For the first few days grain may be kept before the calf. After that the ration given should be such that it will be eaten up clean each time. By the time the calf is six weeks old it usually will eat about one-half pound of grain per day; at the end of two months one pound per day, and a month later two pounds per day. At no time up to six months is it necessary to feed more than this amount, although, if it is desired to push the calves along rapidly, they may be given more up to the limit of their appetite. Any unconsumed grain should be removed from the feed box or manger and fresh grain fed at the next feeding-period.

The most extensive trials with grain supplements were conducted by Curtis and are given in Table 28.

TABLE 28. GRAIN FOR CALVES WITH SKIM MILK. (FOUR CALVES IN EACH LOT)

	LOT I OIL MEAL	LOT II OATMEAL	LOT III CORN MEAI AND FLAXSEED	LOT IV CORN MEAL
	LBS.	LBS.	LBS.	LBS.
Milk	3,760	3,752	3,760	3,759
Hay	1,478	1,481	1,478	1,484
Oil meal	429			
Oatmeal		605		
Corn meal			538	601
Flaxseed			59	
Gain in 74 days	483	498	489	509
Average daily gain per head	1.63	1.68	1.65	1.72
Dry matter per lb. of gain	4.13	4.31	4.32	4.16
Cost of feed per lb. of gain, cents	2.40	2.40	2.0	1.80

These data show that satisfactory results were obtained from all four lots, but on account of the lower market value of corn, Lot III made the cheapest gains.

The general conclusion from the experimental work which is borne out by long experience of practical feeders is that there is little difference in results from different grains. Some feeders have assumed that linseed oil meal should be an especially satisfactory supplement on account of its high food value for other purposes and its palatability. However, so long as the calf is receiving skim milk, it has an abundance of protein of the best possible quality, and there is no reason for adding a high protein concentrate such as linseed oil meal. What is needed by the calf primarily is a concentrate that will supply additional energy. This is secured about as readily from one concentrate as from another. The one to use should depend upon what is available and upon the market price.

In the corn belt where an abundance of corn is always available and where corn is usually cheaper than other grains, it will be the most satisfactory to use, and it will be unnecessary to buy feeds not grown on the farm. A mixture of corn and oats is widely used. Kaffir corn and other grains of the same family also give good results if fed ground.

It was found by Otis that shelled corn gives equal, if not better, results than corn meal, after the calves were well started eating grain. Experiments with self-feeders have demonstrated that calves prefer whole corn and oats to the ground grain, and while the cost of grinding is not very great it is good practice to cater to this preference, as it will result in slower eating and thorough mastication. As the calves approach weaning time, if corn is the ration fed, a change can with advantage be made to part oats, bran, or an oil meal. Otherwise the ration may become too wide and not contain a sufficient amount of protein for best growth.

Feeding Hay and Pasturing. Calves will begin to eat hay if it is placed before them about as soon as they will eat grain. For young calves some feeders prefer early cut timothy to clover or alfalfa, as the calf may eat more of these very palatable roughages than it can properly digest. Further, clover and alfalfa are rather too laxative and tend to produce scours. Hay is generally fed in a rack where the animals have free access to it, except when a good quality of alfalfa hay is fed, when it may be necessary to limit the amount during the first two months. For the calf under three months of age good hay is preferable to pasture grass as roughage, on account of the laxative nature of the grass. From the age of about three months, access to grass supplies the roughage in an entirely satisfactory manner.

Importance of Fresh Milk. In order to make a success of raising the calf on skim milk, the condition of the milk must be uniformly good. One of the common causes of indigestion and its most pronounced symptom, scours, is the feeding of stale milk. As is well known a variety of fermentations begin their activities in milk within a few hours, if the milk is not cooled to a very low temperature. Among these are some that act freely upon the proteins, and the by-products of such decomposition are especially dangerous. A pure acid fermentation is not especially injurious, and in fact a calf may be accustomed to such milk and thrive upon it, if the milk fed is in the same condition each time. Under ordinary conditions the injurious fermentations are liable to develop, and practical experience has shown that it is difficult to get results that will satisfy the particular calf raiser when skim milk is held even 12 hours in an ordinary ice cooler and then warmed for feeding. The best results are obtained only by separating the milk at once after milking and feeding the skim milk immediately. The younger the calf, the more sensitive it is to the condition of the milk. Although it is possible to raise a calf on sour milk after it is well started, provided the milk is fed in the same condition every day—the results are not as satisfactory as with sweet milk. Otis compared buttermilk with sweet milk by feeding ten calves on each. Those receiving skim milk gained an average of 2.02 pounds per day for 126 days, while the group that was fed buttermilk averaged 1.79 pounds per day. The latter group had less trouble from indigestion than those fed with sweet milk.

The Creamery and the Skim Milk Calf. Patrons of creameries who deliver whole milk for separation and take back skim milk have often experienced difficulties in raising calves on this returned milk, especially in warm weather, when the milk sours on the return trip. Another grave danger incident to this practice is the introduction of disease into the herd, as the milk which the patron receives is part of a mixed lot from a number of farms. These troubles can only be avoided by thorough pasteurization of this skim milk at the creamery before it is taken back to the farm. Every creamery receiving whole milk should be equipped to handle skim milk in this manner, and

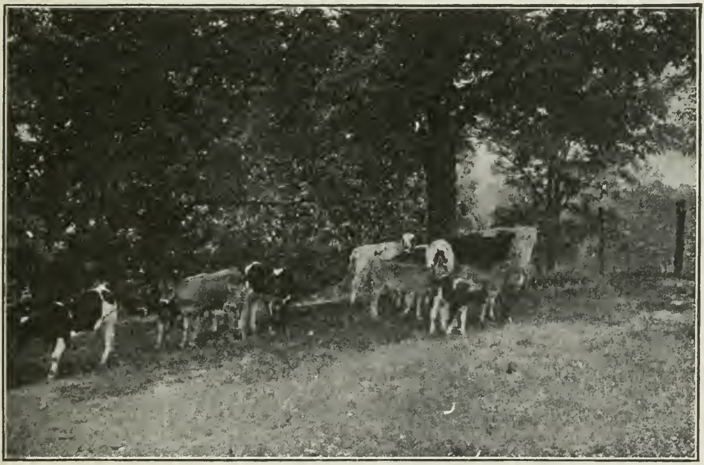


Fig. 45. A group of skim milk calves on pasture. Up to two months calves do best kept in the barn. Later they may be given the freedom of a special pasture. Shade is important.

patrons should insist upon careful pasteurization as a safeguard against disease and calf troubles. Heating to a temperature of 150° F. and holding at that temperature for 30 minutes, or heating to 180° and then cooling, will render the milk safe for feeding purposes. A better practice would be to install a separator on the farm, thereby having the milk sweet and fresh for feeding, and greatly reducing the bulk of product to be hauled to the factory.

The Farm Separator and the Skim Milk Calf. The rapid introduction of the hand separator has largely solved the question of getting good skim milk for calf raising, as well as having several other important advantages. Warm, sweet skim milk, separated within a few minutes after being drawn from the cow, is in the best possible condition for the calf, and by observing the points already mentioned and as practiced by the most successful dairymen, little trouble will be had in raising as good calves as are raised in any way. The majority of those producing cream or butter for sale insist on some means of raising the calf satisfactorily, and the hand separator seems to fill the want better than any other system.

Importance of Keeping Pails Clean. One common cause of sickness in hand-raised calves is feeding from dirty pails or cans. Every utensil which comes in contact with milk to be used for feeding should be kept clean by scalding as thoroughly as though the food were to be used for the owner's family. A good rule is to keep the calf pails as clean as the milk pails. In feeding grain, no more should be fed than will be eaten up clean. If grain is allowed to remain in a trough, it often becomes damp and partly decayed, and may cause sickness, just as dirty pails will often do.

Clean Pens and Barns a Necessity. Another point to be kept in mind is that the young calf must be kept in a clean, well-bedded stall while in the barn. Experience has taught many men that a calf will not do well in a damp, dirty pen or stall, under which conditions pneumonia is almost certain to give trouble. The calf needs all the sunlight it can get, and the well-lighted stall is always best. In arranging a barn the sunniest part should be reserved for the calf pens. In the summer the calf should have access to a small pasture with plenty of shade.

Plenty of Water Needed. An abundance of clean water should be accessible at all times or at frequent intervals, as the calf is not satisfied with milk alone as a drink, and wants to drink a little water at a time, quite often during the day. This thirst for water is often overlooked when calves are raised by hand, and as a result the calf is thirsty as well as hungry, and gorges itself with milk when it has a chance. Salt should also be kept within reach when the calf is old enough to eat grain and hay.

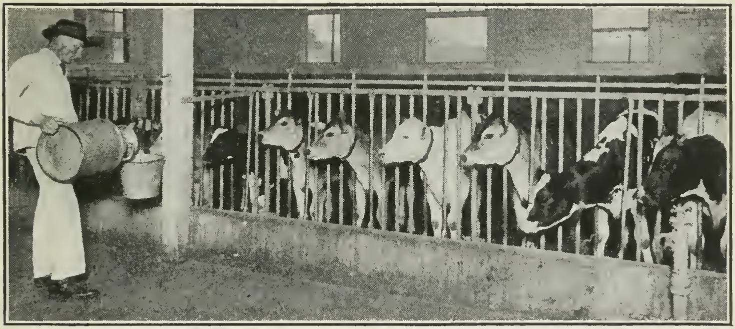


Fig. 46. Calves tied for feeding. Calves should be tied when fed to insure that each individual will get the proper amount of milk and as a convenience for the feeder. Note the feeder is weighing the milk.

Mineral Matter. While our present knowledge of the mineral requirements of growing animals is limited, a wise precaution taken by some of the best calf raisers is to keep a supply of finely ground bone meal before the calves to insure a sufficient supply of calcium and phosphorous.

Fall or Spring Calves. There are a number of advantages in arranging that the calves to be raised by hand shall be dropped in the fall. The calf can be kept growing nicely on skim milk until the grass comes, then weaned and turned out to pasture without checking its growth in the least. The disadvantages of winter feeding and cold weather are more than offset by the hot weather and annoyances from flies experienced by the spring calf. For the calf under six months it does not make much difference whether the roughage be grass or hay. Some prefer the latter, but for the second six months grass gives much better results. In the winter season the young calf is also more apt to receive the careful attention it needs than during the busy summer season. As most heifers come into milk at about two years of age, a fall-dropped heifer is ready to begin milk at the season when the results are the most satisfactory.

Summer calves when young are greatly annoyed by flies and can be made most comfortable by allowing access to a darkened stall during the daytime. Breeders of valuable pure-bred animals find it a good practice to inclose a small pen with fly screen for the young calves.

Weaning. Unless the supply of skim milk is abundant, there is no particular advantage in continuing the milk feeding period beyond six months of age. When the calf reaches this age it is capable of eating a sufficient amount of grain and hay to continue its growth unchecked when the milk is eliminated from the ration. The change should be made gradually so as not to upset the animal's digestion or check the growth. Feed half the usual quantity of milk for five or six days; then reduce the remainder by half, and if there are no unsatisfactory developments, all milk can be discontinued in four or five more days. When weaning begins, the grain mixture should be changed to one with more bran and oil meal to replace the protein in the milk.

Calf Feeding Schedule for Skim Milk Calves. Because of the pronounced difference in size at birth, the feeding schedule in Table 29 is given for Holstein and Jersey calves. Animals of other breeds can be fed according to directions which correspond to their respective sizes at birth.

TABLE 29. FEEDING SCHEDULE FOR CALVES RECEIVING SKIM MILK

AGE DAYS	HOLSTEIN					JERSEY				
	NORMAL WEIGHT LBS.	WHOLE MILK LBS.	SKIM MILK LBS.	GRAIN LBS.	HAY LBS.	NORMAL WEIGHT LBS.	WHOLE MILK LBS.	SKIM MILK LBS.	GRAIN LBS.	HAY LBS.
Birth	89					55				
2		With Dam					With Dam			
3–14		10					6			
15		10	1	¼	¼		7	1	¼	¼
16		10	3	¼	¼		6	2	¼	¼
17		8	4	¼	¼		6	2	¼	¼
18		6	6	¼	¼		5	3	¼	¼
19		4	8	¼	¼		4	4	¼	¼
20		2	10	¼	¼		2	6	¼	¼
21			12	½	¼			9	¼	¼
22– 30	121		12	½	½	76		9	½	¼
31– 60	157		14	1	1	105		12	1	½
61– 90	200		14	2	1½	140		12	1½	1
91–120	249		16	2½	2	174		12–16	2	1½
121–150	302		16–20	3	2½	222		16	2½	1½
151–180	349		16–20	4	3	260		16	3	2

The above table can only be used as a guide to the feeder, and individual cases will necessitate variations in feeding. Calves which are undersized or backward in development should be fed whole milk for a week or two longer. It is well to feed as much hay as they want when the calves are accustomed to it and past the danger of overeating and scouring.

CHAPTER XVII

CALF RAISING (*Continued*)

MILK SUBSTITUTES

Raising Calves without Skim Milk. Dairymen who sell their product as market milk, or to a cheese factory or condensery, are confronted with the problem of raising calves without skim milk, as the separation of a small quantity of milk for calf-feeding involves additional labor cost and further complicates the marketing problem. The use of whole milk entirely for raising young stock on these farms would make the cost of feeding calves prohibitive, as a calf would require 400 to 500 pounds a month for proper development, and at $2 per hundred pounds the calf would consume about $50 worth of milk during the first six months, or the ordinary milk feeding period. Under such conditions there is a strong temptation to veal the calves; but the unsatisfactory results and dangers which follow the practice of replenishing the herd by purchases have already been pointed out.

Three methods are suggested for successfully raising calves on farms where whole milk is sold, and the purpose of each is to limit the use of milk to a minimum quantity. The first is by using a so-called "milk substitute," either a commercial calf meal or home mixture fed as a gruel. The second is the use of a small quantity of whole milk either by dilution or feeding it in conjunction with calf-meal gruel. The third is to use whole milk during the first six or eight weeks to insure a good start in growth and then put the animal on a ration of grain and hay.

Milk Substitutes. Commercial and home-mixed calf-meals have been used quite extensively in experiments designed to find a satisfactory substitute for milk in calf-raising. The requirements necessary to make a mixture of feeds to replace milk in the calf ration are that it be made up of ingredients easily and readily digested by the young animal, palatable, not too costly, and of a chemical composition to correspond closely to that of milk. These few requirements present some serious obstacles, as the list of available feeds of a character adapted to the undeveloped digestive organs of a young calf is decidedly limited. Some of the materials most commonly used are: finely ground corn, middlings, oat flakes, red dog flour, rice flour, flaxseed meal, linseed meal, cocoanut meal, blood meal, and skim milk powder.

Proprietary calf-meals sold under various names have been tested experimentally, and the consensus of opinion is that none of them give satisfactory results as complete substitutes for milk in the calf ration. In all direct comparison with home-mixtures the proprietary feeds have been found inferior. As supplements to milk, or when used to replace part of the milk, both the home-mixed and the commercial calf-meals have given fairly satisfactory results. Success in the use of calf-meals has been found to depend mostly upon getting the calves well started on a milk diet, and continuing the use of milk in a limited way until the animal is able to eat and digest enough of the meal, grain, and hay to continue its growth satisfactorily. Early setbacks are hard to overcome.

A study of the list of feeding stuffs used in the so-called milk substitutes, from the standpoint of the newer knowledge of nutrition, suggests that the difficulty experienced in getting a satisfactory milk substitute also involves the question of vitamines, proteins of a suitable quality, and an adequate supply of mineral matter, especially calcium. Almost any mixture of the feeding stuffs given will be low in Vitamines A and C, and unless blood meal or powdered skim milk is used the quality of the proteins will not be first class; the mineral supply will be dangerously low, under any circumstances.

When the calf reaches an age which makes it possible for considerable roughage to be consumed, the use of suitable kinds, such as alfalfa and clover, correct the deficiencies of a ration based upon cereals and by-products. This accounts for the common observation that satisfactory results can not be secured if milk is dropped entirely from the ration of calves fed milk substitutes before they are able to consume considerable roughage.

Feeding Schedule for Calf Meals. The commercial calf-meals and home-mixtures recommended as milk substitutes are all fed as warm gruels, being mixed with water or milk. As a general rule, in using these meals one pound of the dry meal, either home-mixed or commercial, is mixed with 9 to 10 pounds of water. The amount of gruel fed is about the same as that which would be used in the case of skim milk. Swett[1] recommends the feeding schedule as given in Table 30.

TABLE 30. FEEDING SCHEDULE FOR THE USE OF CALF MEALS

AGE	LBS. MILK DAILY	LBS. GRUEL DAILY	HAY AND GRAIN
1 to 3 days	With dam		
3 to 14 days	10		
14 to 21 days	9	1	Same quantities as for skim milk calves
21 to 30 days	9	3	
30 to 45 days	6	6	
45 to 60 days		12	
60 to 90 days		14	
90 to 120 days		14	

The feeding of the gruel may be continued after four months if desired, although by the time this age is reached the animal will thrive prefectly well on good roughage and a suitable grain ration.

Experimental Results. Experiments with commercial calf-meals are reported by Wing and Savage[1]. One calf meal gave such unsatisfactory results that it was discarded entirely. The others were fed according to the directions of the manufacturers. The feed consumed and the average grain are presented in Table 31.

---

[1] Circular 88, Missouri Experiment Station (1919).

Table 31. Comparison of Results from Calf Meals and Skim Milk

	Skim Milk Group	Commercial Calf Meal S	Commercial Calf Meal B
	Lbs.	Lbs.	Lbs.
Whole milk, lbs.	202	226	207
Skim milk, lbs.	2,477	—	—
Calf meal, lbs.	—	220	270
Grain, lbs.	146	108	108
Hay, lbs.	360	328	307
Daily gains, lbs.	1.53	1.10	.87
Cost lb. gain, cents	4.8	9.0	13.4

Observations of the animals in the three groups were continued to the age of two years. Those raised on the calf meals showed a thrift and development in every way equal to those raised on the skim milk ration. Evidently no permanent result followed the slower growth during the first six months of life.

The results of a number of feeding experiments by Lindsey[2] with home mixtures and proprietary calf meals led to the conclusion that they will serve only as a partial milk substitute. The home mixtures as a whole gave better results than the commercial meals. These home-mixed meals were made up of fine ground corn, flour middlings, flaxseed meal, cheap flour, and glucose sugar.

The most extensive experimental study of this problem was conducted by Hunziker and Caldwell.[3] In order to compare the relative efficiency of skim milk, home-mixed calf meal, and a commercial calf meal, three groups of ten calves each were fed for 26 weeks on the following rations:

---

[1] Bulletins 269 and 304, Cornell University Experiment Station (1909) (1911).

[2] Bulletin 164, Massachusetts Experiment Station (1915).

[3] Bulletin 193, Purdue Experiment Station (1916).

Lot I, whole milk, skim milk, ground corn, and oats as a dry mash, alfalfa hay, and corn silage.

Lot II, whole milk, home-mixed calf meal (containing hominy feed, linseed meal, red dog flour, and dried blood, equal parts by weight), dry mash and roughage same as above.

Lot III, whole milk, a commercial calf meal, dry mash, and roughage same as Lot I.

All calves remained with their dams four or five days and from then on were hand fed. Lot I received whole milk which was gradually replaced with skim milk so that the calves were on a full ration of skim milk at three weeks. Lot II at seven days of age received a small amount of the home-mixed calf meal with the milk. The quantity of meal was gradually increased and mixed with water, one part of meal to seven of water. As this meal and water mixture was increased, the amount of whole milk was decreased, and when the calves were five weeks old the milk was entirely discontinued and they were receiving 18 to 20 ounces of meal a day in water. At six months of age the quantity had been increased to 24 ounces a head daily. For Lot III a small amount of a commercial calf meal was placed in the milk during the second week. This was gradually increased and fed mixed with water according to directions. At five weeks of age all calves in this lot were scheduled to be on a full ration of calf meal consisting of 17 ounces a day. The comparative gains were as given in Table 32.

TABLE 32. PURDUE CALF RAISING EXPERIMENTS
(WEIGHTS AND GAINS OF CALVES)

LOT NO.	GROUP	NO. CALVES	BIRTH WT.	FINAL WT.	GAIN WT.	AV. DAILY GAIN	COST PER LB. GAIN
			Lbs.	Lbs.	Lbs.	Lbs.	Cts.
I.	Skim milk	10	62	283	221	1.21	5.7
II.	Home-mixed calf meal	10	70	244	174	.95	7.4
III.	Commercial calf meal	8	68	201	133	.74	13.18

The feed consumed and the cost of the ration is presented in Table 33. It will be noted that the cost of the skim milk ration and that of the home mixed meal were practically the same while the cost of the commercial calf meal ration was higher and the gain as shown in the previous Table 32 decidedly lower.

TABLE 33. PURDUE CALF RAISING EXPERIMENTS (AMOUNT AND COST OF FEED CONSUMED)

	LOT I		LOT II		LOT III	
	LBS.	COST	LBS.	COST	LBS.	COST
Whole Milk	131	$1.97	213	$3.21	447	$6.72
Skim Milk	2,022	5.05				
Home-mixed calf meal			244	4.88		
Commercial calf meal					195	6.83
Dry Grain	175	2.07	154	1.78	193	1.61
Alfalfa Hay	455	3.42	397	2.98	293	2.20
Corn Silage	61	.12	40	.08	38	.08
Total		$12.63		$12.93		$17.44

The home-mixed calf meal used in these experiments has been widely used and appears to have given results equal to any milk substitute so far tried experimentally. Investigations were continued by Spitzer and Carr[1] for the purpose of testing the efficiency of different proteins of animal and vegetable origin. Expecially satisfactory results were secured from a mixture of corn meal 8 parts, linseed oil meal 1 part, liquid blood 12 parts. The ingredients were mixed together and dried and later ground finely. This preparation has been put on the market as a commercial calf meal. This mixture was tested in comparison with a ration based upon skim milk and upon whole milk using 12 calves in each group. During the 140 days covered by the experiment calves receiving the blood grain mixture made an average gain of 1.18 pounds daily, those receiving the skim milk 1.73

---

[1] Bulletin 246, Purdue Experiment Station (1920).

pounds, and those the whole milk 1.9 pounds. Later development of the calves in the three groups was practically the same.

Raising Calves with the Minimum Amount of Milk. Another plan of raising the calf when whole milk is sold is coming into use. The basis of this practice is the admission that there is no substitute for milk and that the important thing in calf-raising is to give the animal a good start by using milk and then to change the ration as soon as practicable to one of grains and roughage.

Sufficient experimental data are not yet available to establish the absolute minimum amount of milk required, and at best such a figure would vary with the size and the thrift of the calves and their response to the feeder's efforts. The first experimental results along this line were reported by Frazer and Brand[1]. In their first series of experiments three calves cut off entirely from milk at 42, 45, and 46 days of age failed to make satisfactory growth. In a second trial with 12 calves the animals were given a fairly good start on whole milk fed for three weeks, after which they were fed 12 pounds of skim milk a day until eight weeks old, when milk feeding was discontinued. During that period these calves

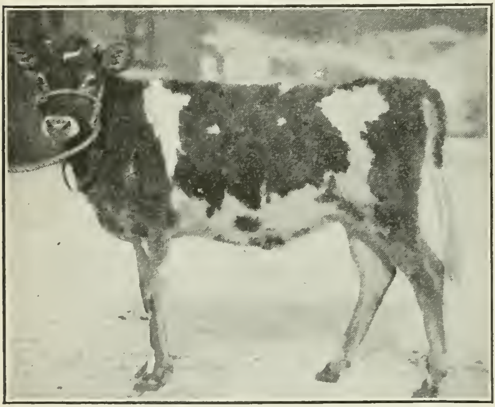


FIG. 47. A Jersey calf 6 months old raised with a minimum amount of milk

This calf received no milk after the age of 60 days. Her weight at 6 months was 260 pounds which is somewhat below normal, but she was normal in weight when one year of age.

---

[1] Bulletin 164, Illinois Experiment Station (1912).

consumed, on the average, 152 pounds whole milk and 435 pounds skim milk. The average gain in weight in ten weeks was 65 pounds, or .93 pound a day. Although the calves were fairly thrifty, it is recommended that where possible more milk should be fed; and although some skim milk was fed in these experiments, if whole milk had been used instead, it is safe to assume that the results would have been more satisfactory, and the total amount used would not have been excessive.

Another method of feeding a limited quantity of whole milk was tried by White and Kuelling[1] in which whole milk was diluted with water. Two calves in the first experiment were fed a mixture of 46 per cent Jersey milk and 54 per cent water. The feeding period was six months and each calf consumed more than a thousand pounds of whole milk, which made the cost excessive. Six other calves received a mixture of milk 3 parts, water 1 part, which was fed after the first month so that the calves received 3½ pounds of milk daily. In addition, grain and hay were fed. The average consumption of whole milk during the six months' period was 765 pounds, and the calves made an average daily gain of 1.15 pounds at a cost of about 21 cents a pound.

The other method of limiting the milk feeding to a minimum quantity is to get the calves well started on a milk ration, at the same time encouraging them to eat as much grain and hay as possible, and then wean them as soon as they are able to continue to develop satisfactorily on grain and hay alone. This plan has been followed experimentally by the Missouri and Minnesota Stations, for the purpose of determining how soon milk feeding can be discontinued without seriously checking the normal growth of the calves. The results are available from eight groups of calves raised successfully according to this plan. The average feed consumption of the calves in the various lots is shown in Table 34.

[1] Bulletin 102, Storrs Experiment Station (1919).

Table 34. Data Concerning Calves Raised with the Minimum Amount of Milk

Group	No. Calves	Breed	Average Age at Weaning	Average Feed Consumed to Six Months of Age			
				Whole Milk	Skim Milk	Grain*	Hay
			Days	Lbs.	Lbs.	Lbs.	Lbs.
1	6	Holstein	66	168	700	438	421
2	4	Holstein	60	170	653	505	243
3	3	Holstein	50	453	—	527	265
4	3	Holstein	60	196	379	467	377
5	3	Jersey	63	133	600	430	341
6	2	Jersey	60	406	—	396	314
7	6	Guernsey	59	375	88	412	295

*Grain mixture: Corn meal 4 parts, wheat bran 1 part, oil meal 1 part.

The results may be judged by the average weights at the age of 6 months as compared to the normal weight for animals of the breeds represented. The data in Table 35 show these facts.

Table 35. Average Weights at Six Months Compared with the Normal

Lot	Weight at Six Months	Normal Weight	Per Cent Normal	Average Daily Gain to Six Months
	Lbs.	Lbs.		Lbs.
1	325	349	93	1.37
2	346	349	99	1.42
3	322	349	92	1.28
4	313	349	90	1.18
5	275	260	105	1.24
6	222	260	86	.90
7	241	—	—	.90

All the animals at weaning time were approximately normally developed as compared to skim milk calves as shown by the percentage of normal in Table 35. For a period of a month to six weeks after milk feeding was discontinued the majority of them lagged behind the normal rate of growth, but this was fully counterbalanced by more rapid development during the remainder of the 6 months' period and at the age of 180 days they were only slightly below normal in size—with the exception of two animals in the first and one in the second group which received timothy hay instead of alfalfa during the last 90 days of the trial.

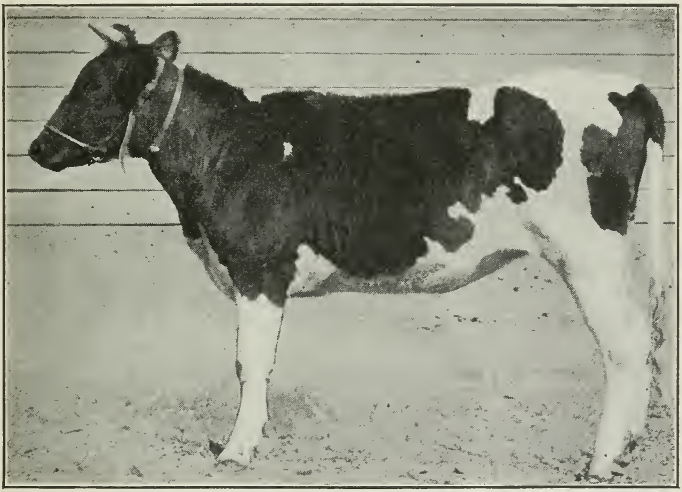


Fig. 48. A Holstein heifer 18 months old, raised with a minimum amount of milk. She received only 449 pounds of milk, and none after 50 days of age. Her grain ration and hay were as recommended in the text. At one year of age she weighed 522 pounds and was 92 per cent normal in size. At 18 months she is in splendid condition and of average size for the breed.

In the case of Groups 1, 2, 4, and 5, Table 34, skim milk was fed in about the same amount as is used in regular practice where this feed is available. The results indicate that calves can be reared successfully by feeding approximately 170 pounds of whole milk and 650 to 700 pounds of skim milk during the first two months to Holstein calves; and somewhat smaller quantities will suffice for Jerseys. Where whole milk only was fed, about

420 to 450 pounds during the first seven weeks for Holsteins and slightly more than 400 pounds in sixty days for Jerseys proved adequate.

Animals in all groups were fed a standard grain mixture, made up of ground corn 4 parts, wheat bran 1 part, and linseed meal 1 part by weight, with slight variations in the amount of the bran at times. Grain feeding began as soon as the calves would eat it (which was usually at about two weeks of age), and it was fed to the limit of the calf's appetite up to a maximum of 5 pounds a day. The roughage used was alfalfa hay, except in the cases noted above. Table 36 gives the feed consumption for the three breeds by 10-day periods.

TABLE 36. AVERAGE AMOUNT HAY AND GRAIN CONSUMED DAILY

AGE DAYS	EIGHTEEN HOLSTEINS		FIVE JERSEYS		SIX GUERNSEYS	
	GRAIN	ALFALFA HAY	GRAIN	HAY	GRAIN	HAY
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
30– 40	0.4	0.1				
40– 50	0.6	0.3	1.0	0.5	0.4	0.4
50– 60	1.5	0.6	1.3	0.6	0.9	0.7
60– 70	2.0	1.0	1.6	0.8	1.2	0.7
70– 80	2.8	1.3	2.2	1.2	1.8	0.8
80– 90	3.3	1.6	2.9	1.9	2.3	1.1
90–100	3.9	1.8	3.3	2.6	2.8	1.8
100–110	4.4	2.1	3.4	2.7	3.0	2.1
110–120	4.5	2.5	3.4	2.7	3.1	2.0
120–130	4.7	2.9	3.5	2.7	3.2	2.3
130–140	4.7	3.3	3.5	3.2	3.4	2.6
140–150	4.7	3.8	4.1	3.8	3.6	2.5
150–160	4.6	4.2	4.3	4.0	3.7	2.7
160–170	4.6	4.6	4.0	3.7	3.8	3.0
170–180	4.6	5.1	4.6	4.2	4.0	3.1

Individual animals within these groups exhibited some variations from the average, and certain ones received milk for slightly longer periods than others. Those that were fed milk longer entered the grain and hay stage more fully developed. These variations in quantity of hay and grain consumed were all reflected in the growth curves of the animals, which goes to prove that success by this method depends upon the feeder's ability to get the calves started early on grain and hay. Another important factor in this system of feeding is to maintain a balance between the quantities of grain and hay fed. Calves prefer the more palatable grain and the feeder should endeavor to bring the animals to consume more hay by limiting the quantity of grain. It was observed that certain calves which were consuming a small proportion of hay at the age of five months had fallen considerably behind the normal rate of growth, but prompt recovery followed when the grain was reduced and the animals began to eat more alfalfa.

To summarize briefly, calves can be successfully raised to normal size by weaning at the age of 50 to 60 days, after giving them a good start on milk, and then feeding a good grain mixture and a legume hay; provided they are taught to eat these feeds at an early age, and the hay and grain are fed in approximately equal amounts.

Powdered Skim Milk for Calf Feeding. A very successful substitute for fresh skim milk is powdered or dried skim milk. It is readily soluble in water and can be quickly dissolved in warm water and fed without delay. While the cost of powdered skim milk is ordinarily prohibitive for use where fresh skim milk is available, it has a distinct place on some farms and will unquestionably be used to a considerable extent when its possibilities are better known. One place where it may be used with advantage is on the farm from which milk is retailed. On such farms a supply of fresh skim milk is generally available a portion of the time but cannot be used to advantage for calf raising on account of a shortage from time to time. Powdered skim milk keeps indefinitely and may be alternated with fresh skim milk without causing any ill effects to the animal. Another condition suggesting its use is where whole milk is sold at wholesale leaving no skim milk available, and if calves are raised making necessary the use of whole milk. By following the plan outlined in previous paragraphs of using the minimum amount of milk, the whole milk used may be reduced from about 400 pounds to around 160 pounds. The market price of the powder usually is such that an amount equivalent to 100 pounds of skim milk will cost about one-half the wholesale price of the same amount of whole milk. By the use of the powdered skim milk a saving can be made approximately one-half the value of 100 pounds of whole milk. At times powder rejected for human food, but equally as good as standard for calf-raising, may be bought at a price considerably below the current market price. Small quantities of malted milk of this class are also on the market and have been found to give good results. For calf feeding dissolve one pound of powder in nine pounds of warm water (100° F.) and feed the calf the same as if fresh skim milk were used.

Whey as a Feed for Calves. Where milk is used for cheese making, it is usual for the whey to belong to the milk producer, and it is used to a small extent as a calf feed. As a rule, the whey is fermented to such an extent before it reaches the farm that its use as a calf feed is out of the question. Where the cheese is made on the farm, or the whey is sterilized at the factory, it may be possible to secure it in a sweet, unfermented condition. Otis[1] reports a trial in which calves fed on skim milk gained 1.32 pounds a day as compared to daily gains of 1.06 for those receiving whey. A Scotch report[2] states that the gradual replacement of whole milk by whey between the third and sixth week, followed by the feeding of whey with grain or other concentrates resulted in calves practically as thrifty and well grown as check lots receiving skim milk and crushed oats. The concentrates fed with the whey included (1) oil meal and fish meal, (2) palm

[1] Bulletin 126, Kansas Experiment Station (1904).
[2] Bulletin 84, Scotland Agricultural College.

nut meal, and (3) fine middlings and fish meal. The percentage composition of whey as compared to skim milk is given as follows:

	SKIM MILK	WHEY
Water	90.50	93.07
Fat	.10	.34
Proteids	3.57	.93
Sugar	4.95	5.00
Ash	.75	.60

It will be observed that the whey contains a little more fat, but only about one-fourth as much proteids as skim milk. The sugar is a trifle higher. The removal of the greater part of the casein in making cheese takes out the most valuable portion of the milk from a food standpoint. If whey is used for calf-raising, a grain ration should be selected that replaces as far as possible the constituents removed in the cheese. Corn is used with skim milk, since the latter is strong in proteids; but with whey, conditions are different, and the proteids must be supplied. Oil meal is generally preferred for this purpose. About one-half pound of oil meal is mixed thoroughly in a gallon of sweet, warm whey, and fed as skim milk. If it is desirable to raise the calf on whey, it should be given its mother's milk for at least six weeks, and then can be changed to the whey. Some prefer to feed the grain dry. The other details of feeding and care are the same as that given in regard to skim milk, and when the whey is secured from a cheese factory the same precaution against fermentation and introduction of disease should be exercised as in the case of skim milk returned from the creamery. Pasteurization is the only safeguard.

GRAINS AND ROUGHAGES

Grain Mixtures. Several recommendations of supplementary grain rations have already been made. Ground corn is most palatable and best adapted for young calves. Ground oats may be added later, likewise wheat bran and oil meal. When the calves are six months old the grain may be fed whole. At weaning time it is well to increase the proportion of oil meal and bran in order to replace the protein of the milk. Almost any mixture of home grown grains makes a satisfactory supplementary feed for calves, bearing in mind the foregoing suggestions.

Roughage. Experiments have proved that legume hays are preferable to timothy or prairie hays for growing calves because they contain more bone making minerals and muscle building proteins. Alfalfa or clover hay should be fed from the start, but if scouring is prevalent it is well to feed timothy, or mixed clover and timothy, until that tendency is overcome. Alfalfa of very good quality should be fed moderately until the calves become accustomed to it, as its laxative qualities may result in looseness where large amounts are eaten. This precaution is seldom necessary if the hay is of a poorer grade.

Silage has been fed to calves experimentally by White and Kuelling, who concluded that a limited amount seemed to increase the appetite of the animals for other feeds, but that nothing can be gained by feeding silage to calves that are less than two months of age, for the amount eaten is small, and in case of digestive disturbances which frequently occur at this young age, it may prove detrimental. Silage varies materially in its acid content from year to year, and high acidity causes scouring. For this reason it is well to feed it only in limited amounts and use fresh silage of the best quality. Any material left in mangers should be cleaned out before the next feeding.

Calf Feeders and Ties

Calf Feeders. Several calf feeders have been devised and used in a small way. They are mostly made on the plan of having a rubber nipple for the calf to suck, and a tube of some kind to draw the milk from the pail. The claim is made that it is better for the calf to drink the milk slowly and mix the saliva with the milk, which is done when the calf takes the milk from the rubber nipple. In practice it is found difficult to keep the tubes clean, and it is more work to feed the calf in this way than by teaching it to drink from the bucket. As to the injurious effects of rapid eating, there are no data at hand on the ground either way; but it is doubtful if it is of any special importance. Saliva probably has very little to do with the digestion of the milk, since the principal office of saliva in digestion is to moisten the food and convert the starches into soluble sugars, and there is no starch in milk.

Ties for Calves. Where valuable calves are raised and it is desirable to take every precaution to keep them in good condition, it is advisable to arrange a series of small pens so each animal may be kept by itself. This not only allows each animal to get the proper amount of feed, but enables the feeder to observe the individual more readily and detect any unusual conditions. The belief has been growing in recent years that much of the sickness of calves, including a portion of that usually classed under the term "scours," is really infectious in character. For this reason in the best equipped barns, not only are individual pens used but the partitions are of solid construction to prevent any communication from one animal to another. A case of common scours from indigestion may often be stopped by decreasing the feed of a certain calf after observing an abnormal condition of the manure so slight that it would not be possible to locate the affected animal in a group.

The best arrangement next to the individual pen, and the one most commonly used, is a large pen or series of pens constructed, in modern barns, of steel—although wood will serve the same purpose—with a row of stanchions along the front for tying the calves during feeding. Some means of tying the calf during feeding should be provided by all means, not only to save labor, but to allow each calf to get its proper share of milk and grain. Calves should never be fed in a trough, as some will drink faster than others and be overfed, while others will be underfed. The same rule applies to the feeding of grain.

Stanchions for calves are constructed much like the old-fashioned rigid stanchions for cows, but smaller. A feed trough is put in front and divisions provided to keep the feed of each calf separate. The pail of milk is set in the trough for the calf to drink. After drinking the milk, the proper amount of grain is put in the trough, and the calves are left tied for some time to eat their portion. This usually prevents them from forming the habit of sucking each other, which is a point of some importance. If the calves are in the pasture, a convenient way is to fasten the stanchions on the fence.

Calf stanchions are usually made from thirty-six to forty-four inches high and twenty-eight inches from center to center, with a space of about four and one-half inches for the neck. The feed trough should not be too wide; about fourteen inches is ample, with a depth of four inches where the stanchions are in the pasture and the calves are not fed hay. A sloping board about 12 inches high along the front of the manger will prevent the calves from spilling the grain out of the manger. In the barn provision should be made for holding a sufficient supply of hay. A rack constructed of steel or wood and placed with the back against the wall and at suitable height is quite satisfactory for this purpose.

VEAL PRODUCTION

Veal Production. Under European conditions, where few cattle are kept especially for meat production, veal occupies a decidedly important place in the meat supply of the people. In America, where the abundance and comparative cheapness of feed has made possible the raising of large numbers of animals primarily or exclusively for beef, veal is of far less importance and has not received much attention. In fact, veal calves are merely a by-product of milk production and the source of supply for a city is in general the same herds which supply it with milk. In milk-shipping districts the practice is altogether too common of selling the heifer calves as well as the male for veal. Others raise the heifers as needed.

The first question that arises in connection with the veal calf is whether the price received justifies the amount of milk necessary to feed the animal until it can be put on the market. True and Gordon[1] state that the veal calf commanding the highest price on the market is one weighing from 140 to 160 pounds at an age of from six to eight weeks. The carcasses of such calves are characterized by flesh of light color and fine grain. The most important factors contributing to the value of a veal are condition and weight for age. With these facts in mind it can readily be seen that the birth weight of the calf is a pertinent factor in the economy of its use for veal, since a calf weighing 100 pounds at birth will reach the most desirable weight in half the time and on approximately half as much milk as the 50-pound calf. Assuming that an average of 10 pounds of milk is necessary to produce one pound of gain, and that milk is worth $2 per 100 pounds and veal ten cents a pound, the cost of raising veal calves to weight of 150 pounds is as shown in Table 37.

TABLE 37. RELATION OF BIRTH WEIGHT OF CALF TO VEAL PRODUCTION

BIRTH WEIGHT OF CALF, LBS.	AMOUNT OF MILK FED, LBS.	VALUE OF MILK	VALUE OF VEAL
40	1,100	$22.00	$15.00
50	1,000	20.00	15.00
60	900	18.00	15.00
70	800	16.00	15.00
80	700	14.00	15.00
90	600	12.00	15.00
100	500	10.00	15.00

---

[1] Circular 196, California Experiment Station (1918).

At these values a calf weighing less than 75 pounds at birth will not bring enough as veal to pay for the milk it consumes. Whether the calf can be raised profitably for veal or not clearly depends upon the price of milk, the market price for veal, and the size of the calf at birth. It is often found that it costs more to feed calves, especially of the smaller breeds, than is received when the calf is sold and for this reason many do not attempt to do so, but destroy all calves not needed for breeders at birth. Where a number of cows freshen at intervals, some of the calves are often raised that otherwise would not be by feeding the milk of the fresh cows up to the time it is fit for market.

Approximately 10 pounds of milk are required for every pound of gain made by the veal calf, but seldom will the selling price of the calf by the pound equal the market value of 10 pounds of milk. Under common conditions every pound of gain on a veal calf is made at a loss. The only profit made is on selling the weight of the calf at birth, and it follows that the younger a calf can be sold as a rule the greater the profit, even though the total income is less. It is for this reason that the tendency is to sell the calf as young as possible and that cities and states have found it necessary to establish regulations concerning the minimum age at which calves may be sold for veal. Three weeks is the standard regulation, but it does not prevent many from reaching the market before this age is reached. The practice of putting calves on the market too young results in much poor quality and a relatively small demand.

Bechdel[1] has also prepared a table from his experimental results showing the returns above feed with milk and veal at varying prices. The animals furnishing the data upon which this table is based were fed an average of 53 days on whole milk and were mostly from the breeds which insure large birth weights. The average daily gain was 1.85 pounds and milk was used at the rate of 9.4 pounds to each pound of gain.

[1] Annual Report, Pennsylvania State College, 1916–17, pp. 337–347.

TABLE 38. THE RELATION OF THE PRICE OF MILK TO COST OF VEAL PRODUCTION

MILK PER CWT.	PRICE OF VEAL PER POUND LIVE WEIGHT								
	8c	9c	10c	11c	12c	14c	16c	18c	20c
1.40	$1.93	$3.27	$5.08	$7.35	$9.13	$12.74	$16.34	$19.94	
1.60	.14	1.94	3.30	5.56	7.35	10.95	14.56	18.16	
1.80	−1.65	.16	1.51	3.76	5.56	9.17	12.77	16.38	
2.00	−3.43	−1.63	− .28	1.98	3.33	7.38	10.99	14.59	
2.20	−5.21	−3.41	−2.06	.19	2.09	5.60	9.20	12.81	$16.41
2.40	−6.99	−5.20	−3.84	−1.59	.21	3.81	7.42	11.02	14.63
2.60	−8.78	−6.99	−5.63	−3.37	1.51	2.03	5.64	9.15	12.84
2.80					3.36	.25	3.85	7.45	11.06
3.00						−1.53	2.08	5.68	9.28
3.40							−1.49	2.11	5.72

Classification of Veal on the Market. Calf carcasses weighing less than 300 pounds and having comparatively light colored flesh are classed as veal. The grade and value of a calf carcass depends upon its form, quality, finish, and weight. The most desirable is a well fatted calf about six weeks of age and weighing 120 to 140 pounds. The flesh should be as nearly white as possible. Dark colored flesh is an indication of too much age, or too much coarse feed. Calves four to six weeks old are preferred, while some are at their prime at eight weeks. Calves under three weeks are condemned. The following are the grades used on the market:[1]

GRADES	EXTREME WEIGHTS	AGE
Choice	80 to 120 lbs.	4 to 8 weeks
Good	70 to 130 lbs.	6 to 10 weeks
Medium or fair . . .	60 to 160 lbs.	5 to 12 weeks
Light or common . .	40 to 75 lbs.	3 to 8 weeks
Heavy	150 to 300 lbs.	Wide range

---

[1] Hall, Bulletin 147, Illinois Experiment Station (1910).

The market price varies widely for veal calves depending upon the quality. The most common faults are: either too heavy or too light, lacking in fat, or flesh too dark colored.

Feeding for Veal. It is a well-established fact that a first-class veal calf must be fed exclusively upon whole milk, or at most must be allowed to consume a very limited amount of hay and grain. The calf is generally taught to drink from a pail as it is not desirable to have a cow that is to be milked nursed by a calf more than two or three days at most. From ten to twelve pounds of milk a day are used at first and gradually increased until a vigorous calf may receive 8 to 10 pounds at a feed twice a day before it is marketed.

Bechdel, using eleven calves, mostly grade Holstein, secured an average daily gain of 1.85 pounds for 53 days with an average consumption of 9.4 pounds whole milk for each pound of gain. The author, using eight Holstein calves, secured an average daily gain of 1.46 pounds to 30 days using 10.02 pounds of milk for each pound of gain. A group of ten Jersey calves weighing 49 pounds at birth averaged 1.3 pounds daily gain for the first 30 days and used 9.4 pounds of milk to the pound of gain. Hayward reports average daily gains ranging from 1.3 to 2.2 pounds with a consumption of 9.8 pounds of milk for each pound of gain. It will be observed that in all cases a pound of gain required about 10 pounds of milk.

Unless the calves are fed a sufficient quantity of milk to reach the market in good condition there is no reason for feeding them for veal at all since the thin and inferior calves bring little more than the value of their hides on the market and seldom pay for the milk they have consumed. Experiments have been made to determine the possibility of using skim milk or milk substitutes for feeding calves designed for sale as veal. The results have showed that this practice cannot be followed successfully. While it is entirely practicable to raise calves for other purposes by these means, to do so satisfactorily requires the use of whole milk a period about as long as the period of feeding a veal calf. A calf put on a milk substitute at an early age will be in a thin or more or less unthrifty condition at the age to be marketed for veal and will be almost unsalable for this purpose although it may later develop into an entirely satisfactory dairy animal.

If an abundance of skim milk is on hand, it may pay to feed calves for meat production to an older age before putting on the market and in this manner utilize the skim milk. Some dairymen using the dairy breeds find this fairly satisfactory, selling the calves at an age of from eight to ten months. However, the dairymen as a rule will find it more profitable to utilize the skim milk by feeding to growing pigs or laying hens than to raise this quality of meat.

Diseases of Calves

The first step toward insuring healthy calves in any herd of cattle is to breed only animals that are free from diseases of the reproductive organs. When conception occurs as the result of the mating of two animals with normal and healthy genital organs, and care is taken to protect the pregnant cow from subsequent exposure to malignant diseases which would affect her reproductive ability, then we may be reasonably sure that the offspring will be born in perfect health.

The next step is to take proper precaution for the reception of the new-born animal, by providing the dam with a clean, roomy stall, freshly bedded with dry clean bedding. After the calf is born, remove any persistent membrane or mucus from the mouth and nostrils, and allow the cow to lick it dry. Later the navel cord should be dipped in tincture of iodine and dusted with boric acid.

All precautions having been observed to insure a healthy calf at birth, the animal, if worth raising to maturity, can best be raised by housing it in sanitary, dry, well ventilated quarters with provision for sunshine, fresh air, and exercise, and by feeding it to induce satisfactory growth and development.

In writing of diseases of calves we are dealing with a subject on which present-day knowledge is scant, and the whole field of calf ailments and their prevention and cure afford a splendid opportunity for study and research. The subject is now receiving more serious consideration by a number of investigators; but the nature of some of the maladies which afflict young animals, and methods of control and cure are still far from a satisfactory solution. This lack of knowledge is causing great economic waste, as the rate of mortality for young calves of the dairy breeds is appallingly high. Many of the animals are lost each year through lack of care and intelligent handling on the part of feeders.

Scours from Indigestion. The most common ailment of calves, particularly those which are bucket fed, is scours, or looseness of the bowels. This trouble should not be confused with white scours, or calf cholera, which will be discussed later on. Common scours, or indigestion, is due to various causes, the chief of which are overfeeding; use of old milk, sour milk, cold milk, or milk too rich in fat; irregular feeding; dirty pails or mangers; unsanitary, damp pens; or occasionally, even too much leafy alfalfa.

The first symptoms are listlessness, loss of appetite sometimes accompanied by slight bloating, and a diarrheal condition causing the discharge of semi-fluid, dark-colored, foul-smelling feces, which stain the tail and hocks of the animal. On the first indication of the disorder the ration should be cut down to one-half the usual amount. It is well to add one teaspoonful per pint of milk fed of a mixture of one-half ounce of formaline in 15½ ounces of water. After two or three feeding periods, the milk given may again be increased to the usual quantity. The formaline should be given for two or three days at least.

When a severe case of scours appears, the feed should be at once reduced. A drench of three ounces of castor oil in a pint of milk may be given then to advantage. This may be followed by a teaspoonful of a mixture of one part salol and two parts subnitrate of bismuth three times daily for two or three days until the condition of the animal improves. It is well to give the animal the formaline mixture for several days while it is recovering from a severe attack. If the discharge from the bowel has a sour odor, two or three teaspoonfuls of lime water should be added to the milk.

Neglected cases of scours in time become chronic, causing a highly inflamed condition of the digestive tract. The animal grows listless and loses flesh, and the hide is tight and the hair upstanding. These chronic cases will yield to careful treatment but it requires a long period for full recovery from the severe setback in growth.

While ordinary scours is not necessarily contagious, it is good practice to separate sick calves from the rest of the herd so that they may be watched and given proper treatment. This also prevents the other calves from becoming soiled by the droppings of the scouring calves.

Bloody Scours. Another form of scours which attacks small calves or those of low vitality at the age of 3 to 5 weeks is sometimes called bloody scours, because the discharges from the bowels are streaked with blood and sometimes appear to be pure blood. This disease works rapidly, and calves often succumb in two or three days. It is apparently highly contagious and the weaker animals are very susceptible. It is therefore essential that calves should be isolated as soon as detected, and all soiled bedding destroyed and stalls disinfected before healthy animals are allowed to occupy them. Some success has followed the use of fluid extract of gelsemium administered in doses of two teaspoonfuls three or four times a day. Recovery is slow and extreme care should be exercised when feeding is resumed.

White Scours. White scours is a germ disease which attacks calves at birth or shortly after they are dropped. Symptoms of dullness, frequently inability to arise, sunken eyes, increased respiration, and profuse discharge of dirty or yellowish white pasty feces with a highly offensive odor. The disease is ordinarily fatal and the body should be burnt or buried to prevent spread of the infection, which is highly contagious. Similar precautions should be observed in disposing of bedding and other materials fouled by the discharges.

It was at one time believed that this disease gained entrance through the broken navel cord, but later investigation indicates that there are three sources of infection. During intra-uterine life the fetus may swallow the germs present in the amniotic fluid. After birth the young calf is exposed to infection in the discharge from the vulva of the cow which foul the udder and teats. Or the presence of other sick calves in adjacent pens with open partitions, or soiled bedding in the calf pen may expose the new-born calf to the disease.

The fact that white scours is often prevalent in herds affected severely with contagious abortion has led some authorities to conclude that there is a close association between the two diseases as well as calf pneumonia and arthritis, or acute swelling of the joints in calves. However the case may be, it is well to take particular pains to isolate all calves dropped by cows showing abnormal discharges from the vagina or retained afterbirth. This will prevent their infecting other calves if the disease develops. The navel cords of all calves should be treated with tincture of iodine at birth and dusted with boric acid.

If an outbreak of white scours should occur, the first step to check it would be to destroy the carcasses of any dead calves, together with all bedding and soiled material from the calf barn. The calf pens and maternity stalls should be thoroughly disinfected. A serum is also on the market which has given results in preventing this disease. In using the serum each calf is given a dose hypodermically soon after birth, followed by a dose daily if scouring develops until the feces are normal. Along with this treatment the calf may be given an enema of physiological salt solution (80 grams of salt to a quart of water) and a fourth of one per cent of Langols solution to remove the meconium, the material found in the bowel at birth. This treatment should be given before the calf is permitted to feed. The udder and teats of the cow should be thoroughly cleansed and disinfected before allowing the calf to suck or before drawing milk to feed it. The calf should receive the dam's milk only for 8 or 10 days. The serum is expensive and its use is only justifiable where the calves are valuable. Two kinds are available, white scours serum, which is best for prevention and first treatments, and polyvalent colon bacterin, which is used for chronic cases.

Calf Pneumonia. One form of bronchial pneumonia which attacks the lower part of one or both anterior lobes of the lungs is usually associated with white scours, and bacteriologically closely related to the other disease. This disease acts slowly and usually affects the older calves. It is accompanied by loss of appetite, general weakness, and more or less coughing. The calf serum mentioned above is recommended for treatment, as the infection is believed to be due to the same organism which causes white scours.

Another form of pneumonia is often contracted by calves which are housed in cold, poorly ventilated quarters or subjected to severe exposure in inclement weather. This disease is accompanied by high temperature ranging from 104° to 106° F., complete loss of appetite, harsh, dry skin, upstanding hair, and short respiration accompanied by a spasmodic jerking in the flanks. Severe cases are ordinarily fatal and the only treatment recommended is placing the animals in dry, warm quarters, blanketing them, and administering a mild purgative such as castor oil. If the animal is successful in combating the disease, it is usually left in an extremely weak condition, and the use of nux vomica as a stimulant may be resorted to until its strength returns with renewal of appetite.

Arthritis. Arthritis or Acute Swelling and Inflammation of the Joints. This is another condition associated with white scours. The symptoms are stiffness of one or more of the joints of the legs, accompanied by swelling and a feeling of hotness and soreness to the touch. The animal shows no inclination to move about. Since our present knowledge indicates a close relationship between this condition and white scours, the same precautions and methods of control are recommended for its treatment.

Navel Ills. Painful inflammation of the region of the navel, accompanied by discharge of pus are sometimes found in calves two or three days after birth, and this trouble is ordinarily traceable to infection acquired at the time of birth or from dirty bedding. Prevention is almost certain if the navel is treated as recommended and due care exercised with regard to cleanliness of the calving quarters. If there is a swelling or discharge of pus, this should be opened and cleaned with disinfectant solution, and packed with cotton saturated with iodine or thoroughly powered with boric acid.

There are a number of other diseases to which calves are subject, but when strictly sanitary conditions are observed in bedding and feeding the young animals, their presence is rare. One occasionally encounters goiter, sore throat, rickets, paint poisoning, black leg, and eye troubles, but unless the disease is easily recognized, it is well to have an examination by a veterinarian.

Ringworm. This is a form of skin infection which often breaks out while the calves are in winter quarters, and is characterized by unsightly spots from which the hair is lost. This is accompanied by itching which irritates the animals. The disease spreads rapidly and can only be checked by cleaning up the quarters, and applying whitewash or disinfectant to the walls and partitions. The skin over the infected areas should be washed with soap and water, scraped, and then treated with tincture of iodine.

Lice. Calves are subject to much annoyance by these parasites, especially when closely housed for the winter. Their presence can be detected by a disposition on the part of the calves to rub themselves, and when the hair is parted over the withers and along the spinal column the lice can be seen. It is well to examine the calves during the winter and spring for the presence of lice. The animals, to rid them of the parasites, may be washed with kerosene emulsion and the treatment repeated after a week or ten days to kill those which hatch from the eggs. Lime-sulphur dip and nicotine dip are also effective. If the weather is too severe to permit washing, relief can be obtained by dusting the infested parts with gound sabadilla seed, using care not to get the material into the eyes or mouths of the calves. This treatment can be repeated as often as necessary.

CHAPTER XVIII

FACTORS INFLUENCING GROWTH AND DEVELOPMENT OF DAIRY HEIFERS

Every breeder of dairy cattle is interested in knowing what factors are at work during the growing period of the heifer's life and what effect these forces may have on the development and future producing ability of the animal. The economic importance of a thorough study of the problems of growth and factors bearing thereon have made this a fruitful field for research and experimentation, and the progress of scientific study has led investigators deeper and deeper into the mysteries of growth, the natural laws and forces which govern it, and the influences and effects of nutrition on the functioning of those laws and forces.

Nature of Growth. An entirely satisfactory definition of the term "growth" is lacking, but the general understanding is that it embraces that series of changes in size and structure by which an individual of any species develops from the fertilized egg to maturity. Increases in size may be brought about by multiplication of the cells, enlargement of the individual cells, or deposition of material between the cells. The first of these is without doubt the most important.

Two Factors Concerned in Growth. Growth is an exceedingly complicated phenomenon. Although the outward manifestations of growth have been observed by man since human intelligence first came into existence, the nature and cause of growth is still far from a complete solution. The general conception should be developed first of all that the causes operating in growth are of two general classes: (1) the internal factors and (2) the external factors. These two classes of causes are discussed somewhat in detail in later paragraphs.

It might be well to point out at this point the analogy to the production of milk. The secretion of milk likewise is controlled by two classes of factors which may be described in the same terms, internal and external. The external factors in both milk production and growth are the environment of the animal, including feed, housing, care, and management in general.

Limits of Growth. The upper limit of the skeletal size attained by any individual under favorable conditions is determined by heredity, and even the greatest intake of food will not cause this limit to be exceeded. This heritage falls within the limits of size of the species, and there is found in every species individual variations between the upper and lower limits, although the great majority of the members are grouped close to the average size.

Measuring Growth. Students of the effects of various factors on growth generally conduct their experiments with laboratory animals. These are used in large numbers, and weight is the common standard for measuring growth. By weighing a great many animals receiving a normal ration, figures have been secured which represent the normal growth, and these figures represented graphically are known as a curve of normal growth. The growth of experimental animals is compared to these normal growth curves to determine the effect of the factors studied on the growth of the animals.

Until comparatively recent times the growth of larger animals has been measured almost entirely by means of their body weight. It is now recognized that this is not a satisfactory way to measure growth, because the body weight and skeletal growth are, to a considerable degree, independent of each other. The growth of the skeleton continues to a certain extent, whether the tissues are storing up energy in the form of fat during a period of liberal feeding, or whether they are giving up energy as the result of a low plane of nutrition. It has been found experimentally that the influence of the factor of nutrition alone caused a variation of over 40 per cent in the weights of animals on different planes of nutrition; whereas the variation in height was less than 10 per cent for the same group of heifers. The weight of an animal certainly cannot be used alone as a fair measure of growth when the weight in relation to the growth of the skeleton can so readily be made to fluctuate between such wide limits. Attempts have been made to find a way to represent growth by a single term, but as yet no satisfactory method has been devised. It seems necessary to represent the growth of body tissue in one term, and that of the skeleton by another. So far, no more satisfactory method than weight has been suggested for measuring increase in body tissue, and the skeletal growth by means of certain measurements.

The author, after a thorough study of a series of 21 measurements taken on a large number of growing animals, concluded that the growth of the various parts of the body proceeds in rather definite ratios. The rapid increase in length comes at the same time as the rapid gain in height or circumference; so a measurement taken of the growth of one part of the body makes it possible to estimate closely the rapidity of growth and the time at which it occurs. The general conclusion seems justified that any one of the fundamental measurements of the body may be used with a fair degree of accuracy as an index of skeletal growth.

A study of the monthly measurements taken on 16 dairy heifers from birth to maturity leads to the conclusion that any one of several skeletal measurements may be used as a measure of the growth of the skeleton. On account of the small limit of error, and the ease with which it is taken, the height at withers is selected as the measure of skeletal growth. The growth of the animals is measured by two units: (1) gain in live weight, and (2) increase in height at withers.

Normal Growth. To afford a basis of measurement of growth, weights and measurements were taken at the University of

Missouri of pure-bred animals handled under what is considered normal conditions. These data given in Tables 39 and 40 may be used as a standard in studying the growth and development of animals of the breed represented, in the same manner as the growth curves are used in experiments with laboratory animals, and from these tables similar growth curves may be drawn for the various breeds of cattle.

TABLE 39. NORMAL HEIGHT AT WITHERS OF FEMALES DURING THE GROWING PERIOD

AGE	HOLSTEINS	JERSEYS	DAIRY SHORTHORNS	AYRSHIRES
MONTHS	INCHES	INCHES	INCHES	INCHES
BIRTH	28.3	26.0		
1	30.2	27.7	31.1	27.5
2	32.3	29.4	32.1	29.5
3	34.2	31.2	33.9	31.2
4	36.2	32.9	35.8	33.1
5	38.0	35.1	37.0	35.1
6	39.7	36.9	38.5	36.4
7	40.9	38.1	40.0	37.3
8	42.2	39.3	41.1	38.5
9	42.9	40.5	41.9	39.0
10	43.8	41.3	43.3	39.6
11	44.3	41.9	43.8	40.1
12	44.8	42.6	44.4	40.7
13	45.6	43.3	45.1	41.3
14	46.2	43.8	45.4	42.0
15	46.8	44.4	45.9	42.4
16	47.4	44.6	47.0	42.7
17	47.7	45.1	47.2	43.1
18	47.9	45.5	47.7	43.7
19	48.3	46.0	48.2	44.2
20	48.7	46.3	48.5	44.6
21	48.9	46.5	48.8	44.9
22	49.2	46.8	49.1	45.4
23	49.5	47.2	49.5	45.6
24	49.8	47.4	49.8	45.9
25	50.2		50.2	46.6

TABLE 39, continued

AGE	HOLSTEINS	JERSEYS	DAIRY SHORTHORNS	AYRSHIRES
MONTHS	INCHES	INCHES	INCHES	INCHES
26	50.5		50.4	46.7
27	50.9	48.0	50.6	46.8
28	51.1		50.7	46.9
29	51.3		50.7	47.0
30	51.5	48.3	51.3	47.2
33	52.0	48.5	51.7	47.7
36	52.3	48.8	52.0	47.9
42	52.6	49.0	53.0	48.3
48	53.1	49.4	53.5	48.5
54	53.3	49.3	53.7	49.0
60	53.6		54.1	49.0
72	54.0			

TABLE 40. NORMAL WEIGHT OF FEMALES

AGE	HOLSTEIN	JERSEY	AYRSHIRE	DAIRY SHORTHORN
MONTHS	POUNDS	POUNDS	POUNDS	POUNDS
BIRTH	90	55	69	73
1	121	76	90	118
2	157	105	128	133
3	200	140	170	174
4	249	174	218	225
5	302	222	254	268
6	349	260	286	316
7	389	302	304	348
8	425	340	336	419
9	466	376	366	461
10	501	407	406	538
11	529	432	427	576
12	558	456	456	547
13	574	480	485	564
14	596	503	533	579
15	612	520	547	617
16	643	533	560	627

TABLE 40, continued

AGE	HOLSTEIN	JERSEY	AYRSHIRE	DAIRY SHORTHORN
Months	Pounds	Pounds	Pounds	Pounds
17	660	553	579	642
18	686	572	604	668
19	715	598	627	695
20	746	621	651	728
21	774	649	679	745
22	796	668	707	741
23	824	689	733	821
24	841	716	759	845
25	869	737	798	845
26	893	758	807	877
27	925	770	859	885
28	966	784		922
29	994	804		928
30	1,021			998

Internal Cause of Growth. At the time of the fertilization of the egg, or union of the sperm and ovum, a powerful force is set in motion. This "growth stimulus or impulse" is generally believed to continue to operate until it is spent by the organism in achieving its complete growth. Its action may be retarded by adverse conditions, but with favorable environment, its function is revived and growth often proceeds at an accelerated rate. The exact nature of this inherent growth impulse has not been determined, but its presence is no longer questioned, and its persistence has been repeatedly demonstrated by dogged efforts of animals to grow under most unfavorable circumstances.

It would appear that the growth stimulus is stronger in the youthful cell and then, with advancing age and development as the cell structure becomes more complex, the impulse dies down; at least, observation would lead to this belief. However, there is also the possibility that with advancing age, other inhibitory forces are set up which overcome and counteract the original power of growth.

Although conclusive proof is lacking, it seems to be the general opinion that hormones or secretions of ductless glands are responsible for the growth stimulation, and one authority states that it seems likely that in organisms in general the normal growth of each tissue or of each organ is controlled separately by a specific internal secretion; and that these substances may regulate growth either through inhibition or acceleration, and the effect produced may be due either to the presence or the withdrawal of the specific substance. The glands supposed to be especially connected with the phenomena of growth are the thyroid, the pituitary body or hypophysis, and pineal and the thymus glands, ovaries and testes. Investigators have found that some of these glands function at a very early age in the fetus, and it is safe to assume that before the fetal organs can elaborate these growth-inducing secretions, they may be drawn from the glands of the parent.

The persistence to continue skeletal growth shown by animals under adverse conditions, even when they show a loss in body weight, indicates strongly that the growth tendency exists to a greater extent within the skeleton than within the soft tissues.

The growth stimulus, together with other substances contained in the secretions of the ductless glands and in other organs which tend either to speed up or slow down the rate of growth constitute the internal factors influencing growth. These factors are in no way under control of the feeder, except in so far as the food materials may effect the functioning of these organs. To these factors must be added the external factors, some of which are under control of the breeder. In this category are listed the size of the calf at birth, its breed, and conditions of heat, light, ventilation, gestation, lactation, and nutrition.

Influence of the Size of Calf at Birth on Growth. In discussing the relation of the size of the calf at birth to the rate of growth and size of the animal at maturity, it is well to consider first the factors influencing the size of the calf at birth. Breed is the most important of these factors, and that factor continues its influence throughout the life of the animal; it is consequently treated in a separate paragraph. The difference in size of calves due to sex is eliminated from this discussion, since we are dealing only with females. Calves from immature dams or those of advanced age are usually smaller than the offspring of cows from 5 to 10 years old. Length of gestation and nutrition of the cow during that period do not affect the size of the calf at birth to any appreciable extent except under the most extreme conditions.

It is evident from the above that within a given breed there are no potent factors at work to influence the development of the calf in utero which might reflect on its future growth. Therefore we may assume that regardless of birth weight, normal and healthy calves are born with an equal chance to grow.

A careful study of the growth of calves grouped according to birth weights as below normal, normal, and above normal, reveals evidence of a slight relationship between the size of animals at birth and at maturity; but a further analysis of individual cases shows striking exceptions to this general rule. The most that can be said is that generally there seems to be a slight tendency toward a direct relationship between size of animals at birth and maturity, but individuals show such wide variations that little practical importance should be attached to this point.

Breed as a Factor in Growth. The influence of breed on the growth and development of heifers is best illustrated by the Tables 39 and 40. Discussing more particularly the Holstein and Jersey breeds, the facts shown may be summarized as follows:

The rate of growth in skeleton by the Jersey and Holstein is practically the same from birth to 24 months, but it is greater by the Holsteins from this date on. The rate of gain in weight from birth is somewhat greater by the Holsteins. There is a well marked breed characteristic with reference to the age at maturity. The Jersey reaches maturity in skeletal growth between 3 and 4 years, the Holstein between 4 and 5 years. The maximum weight is reached by both breeds about two years after the growth of skeleton ceases.

Heat, Light, and Ventilation. Proper development and satisfactory growth are dependent upon the three factors here mentioned; but they are ordinarily adequately controlled by the breeder and can be regulated by proper housing. Young animals exposed to inclement weather or stabled in dark and poorly ventilated quarters will usually be backward in growth and susceptible to disease. These matters will be dealt with in more detail in later chapters.

Effect of Gestation upon Growth. A popular misconception has long existed regarding the effect of gestation on the growth and development of heifers. The common belief was that the development of a fetus resulted in a drain on the nutrients and materials of the cow's body which was reflected in the growth, or rather lack of growth, of the parent. Experimental observation has proved that this belief is without foundation, and results of analyses show that the amount of dry matter contained in the fetus and its accompanying fluid and membranes is very small. A Jersey cow produces a total of only fifteen or twenty and a Holstein twenty or twenty-five pounds of dry matter in the fetus and its accompanying fluids and membranes. On the dry-matter basis, a Jersey calf is equivalent to from 110 to 170 pounds of Jersey milk. In the Holstein breed the calf at birth will contain as much dry matter as from 200 to 275 pounds of Holstein milk.

After a careful study of various groups of heifers, the general conclusion drawn is that while gestation does exert a measurable effect upon the skeleton growth of dairy heifers the check is so slight that for all practical purposes it may be entirely ignored.

If the growth of the animal is measured by weight, no check is found which is due to gestation. Pregnant animals shortly before parturition will outweigh open animals of the same age which have received the same ration. Weights taken following parturition show little difference between groups which have

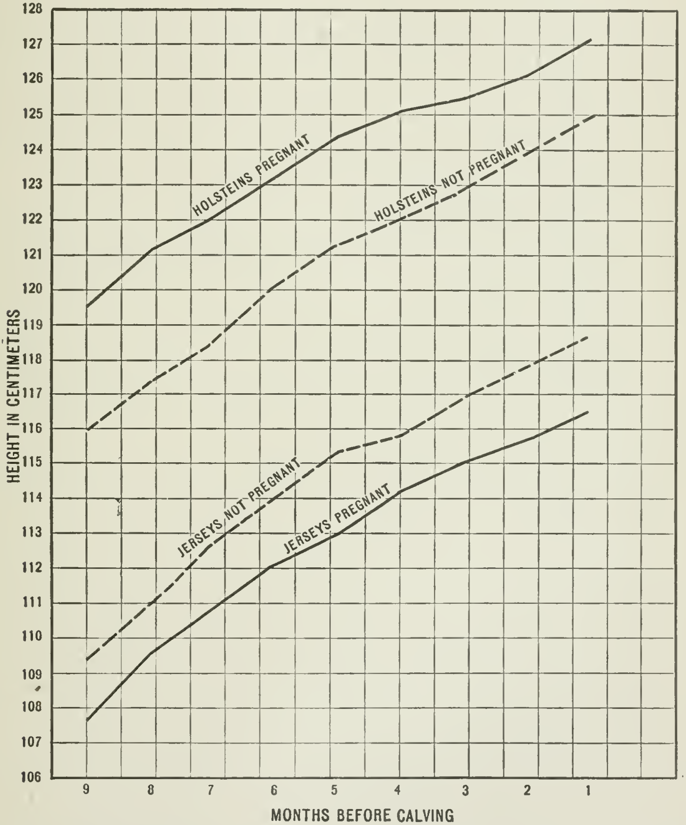


FIG. 49. The influence of gestation upon skeletal growth. Pregnancy has very little effect upon the growth of dairy heifers. Gestation is not a severe tax upon the mother, as is often assumed.

developed the fetus and the open groups of the same age. In brief it may be said that gestation has practically no effect upon the rate of growth of heifers.

Effect of Lactation upon Growth. It is undoubtedly true that observation has led to the erroneous conception that gestation is responsible for the retarded growth of many heifers which freshen at an early age. The observation is correct, but the cause for the stunting of the growth of the animal lies not in the use of food materials for producing a fetus, but is due to the enormous drain placed on the heifer by the prolonged use of nutrients from her food supply for the elaboration of milk during the lactation period immediately following parturition.

The extent to which milk secretion taxes the animal is seldom realized. A comparison with a steer on full feed makes the facts more impressive. A steer making the very satisfactory gain of 2 pounds a day is adding dry matter to his body at the rate of 1.5 pounds daily. A cow producing the very ordinary amount of 30 pounds of milk daily is producing 3.75 pounds of dry matter in her milk, or more than twice that found in the gain made by a steer on full feed.

On the other hand, as shown above, the milk which a good heifer produces during four or five days contains as much dry matter as was needed during nine months to grow the fetus. The only source of supply for this material is the food she consumes, and in the case of a high producing animal, she is sometimes forced to draw on her body tissues to supplement this outside supply. During the early stages of lactation the stimulus to produce milk is so insistent in well-bred dairy cows that it takes precedence over the other demands of the animal body. This, of course, results not only in a temporary check on growth, but is reflected often in the ultimate size of the animal.

To illustrate the effect of lactation, weights and measurements on two groups of heifers are here cited. The groups were bred so that the late calving heifers would drop their first calves at the same age the early calving groups came fresh the second time. Height measurements taken the month before the early

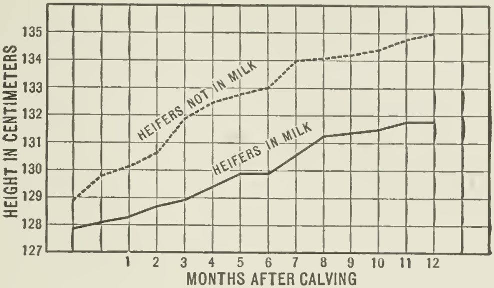


Fig. 50. The influence of lactation upon skeletal growth

The figure represents results from two groups of Holsteins. One month before calving the pregnant group averaged one centimeter less in height than the non-pregnant. After 12 months in milk the same group was 3.2 centimeters below in height. In contrast to pregnancy lactation exerts a strong influence upon growth.

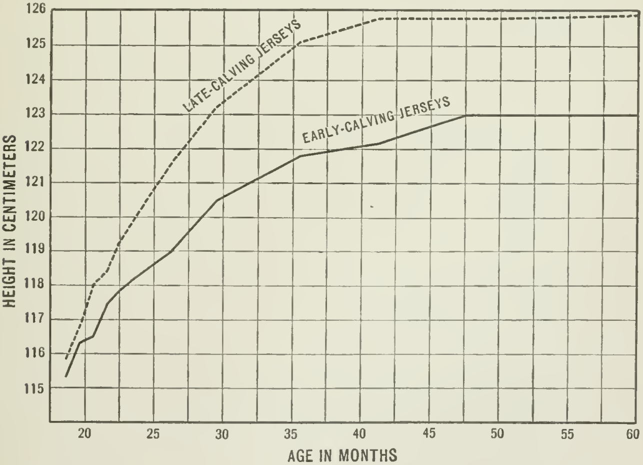


Fig. 51. The influence of early calving upon the size of the animal when mature

This chart represents the average results from two groups of Jerseys. One group calved between the ages of 22 to 25 months, the second between the ages of 34 to 36 months. Both received the same kind of feed. Note at 18 months there was little difference in size but the late calving group made more growth while the early calving group was in milk between 24 and 36 months. As a result the late calving group were larger animals at maturity.

groups calved and the month before their second calving and the first parturition of the late groups indicate that during this period one set of early-calving heifers gained 5.2 centimeters as compared to 6.8 centimeters for the late-calving; while another set of early-calving animals gained 3.8 centimeters to 6.1 centimeters gained by late-calving heifers. The difference in gains in weight is even more significant. The Jersey group which calved early weighed 606 pounds before first calving and at the same age the group which calved later weighed 616 pounds. The 606-pound group weighed 805 pounds after freshening the first time. In other words, the heifers in milk made an average gain of 80 pounds and during the same period the late bred heifers carrying first calf gained 189 pounds. Both groups received similar treatment. Results with Holstein heifers are very much the same.

The continued effect of early calving is illustrated by the data in Table 41.

TABLE 41. INFLUENCE OF THE AGE OF FIRST CALVING UPON THE GROWTH OF DAIRY HEIFERS

	LIGHT-FED JERSEYS		HEAVY-FED JERSEYS		HEAVY-FED HOLSTEINS	
AGE	EARLY-CALVING 7 ANIMALS	LATE-CALVING 5 ANIMALS	EARLY-CALVING 4 ANIMALS	LATE-CALVING 5 ANIMALS	EARLY-CALVING 4 ANIMALS	LATE-CALVING 5 ANIMALS
MONTHS	HEIGHT CENTIMETERS	HEIGHT CENTIMETERS	HEIGHT CENTIMETERS	HEIGHT CENTIMETERS	HEIGHT CENTIMETERS	HEIGHT CENTIMETERS
19	111.1	113.6	119.5	118.1	126.5	127.3
60	121.3	124.6	124.7	127.2	134.1	137.6
Total Increase	10.2	11.0	5.2	9.1	7.6	10.3
AGE MONTHS	WEIGHT LBS.	WEIGHT LBS.	WEIGHT LBS.	WEIGHT LBS.	WEIGHT LBS.	WEIGHT LBS.
19	504	524	759	732	942	922
66	866	895	889	984	1,214	1,299
78	865	928			1,221	1,280
Total Increase	361	404	130	252	279	358

Without exception the early-calving groups were smaller in size and lighter in weight at maturity than those calving later; despite the fact that two of the three latter groups were lighter and one smaller than the former groups at 19 months of age.

The effect of lactation is not limited to retardation of growth for a short time, but it is so marked that the final size of the animal at maturity is influenced to some extent by the age at first freshening, and heifers which calve at an early age are generally smaller when mature than those animals which calve for the first time after they are more mature.

In conclusion it can be said that the growth of a lactating animal is checked materially both in regard to the skeleton and the weight. Heifers in milk make decidedly less growth than animals of the same age and breed that are farrow or pregnant. The effect of early lactation is sufficient to check the growth of the animal to the extent that the size at maturity is somewhat influenced. Heifers which calve when 20 to 24 months old do not average so large at maturity as heifers that calve first when 28 to 34 months old.

Effect of Nutrition on Growth. Food supply is by far the most important factor under the control of man in rearing domestic animals. The inherited growth impulse and the factor of nutrition are closely involved and dependent on each other. Nutrition can only give growth impulse full play, but neither can succeed without the other. The stimulus to grow must be suspended when adequate food is lacking; but on the other hand, no amount of food can force the animal to grow beyond its predetermined size; and when its growth impulse is spent, heavy feeding cannot revive nor recreate it.

As a result of extensive study and observation during the past decade we now realize that for the successful accomplishment of our aims in cattle feeding the dairy ration must not only be sufficient in quantity, but must be complete in the quality of its makeup. In other words, we must recognize and incorporate into our feeding practices the facts which have been brought to light by careful studies in animal nutrition.

Until recently, protein, carbohydrates, and fats in quantities as specified by feeding standards were believed to fill the demands of a complete diet. Then came recognition of the fact that the mineral constituents of the diet were of importance. Physiologists studied the digestion of proteins and their use in the animal body, and soon realized that proteins were not all alike. Chemists took up the problem and analyzed the proteins, thereby discovering the remarkable differences in their structure. Feeding of purified food substances brought to the notice of investigators other heretofore unknown dietary essentials, which were first made conspicuous by their absence in supposedly complete diets. Each new discovery was the result of extensive investigational work, and one by one the new factors have been studied, analyzed, and finally embodied in our fund of knowledge regarding nutrition.

The chief function of the carbohydrate foods in the ration is to supply energy to carry on the life processes, maintain the warmth of the body, to build adipose or reserve tissue, and in the case of lactating animals, to furnish materials for the milk sugar and butter fat in the milk. The ordinary feeding stuffs contain an abundance of carbohydrates, and the matter of adequate supply of energy need not give the feeder much trouble if he follows the feeding standard.

The protein of the ration is utilized to replace worn out tissue and to build new tissue as the animal grows. In addition the highly specialized cells and organs demand specific amino acids (parts of proteins) in order to continue their normal functions, and unless the food supply furnishes these substances in adequate amounts, physiological disturbances result. Proteins are used to a limited extent to supply energy also. During lactation the food supplies proteins used in the milk.

In the process of protein digestion, the animal and vegetable proteins are broken up in their component parts, the amino acids. Eighteen of these so-called "building stones" have been isolated and identified, and they all enter into the structure of the proteins of the animal body. Since this is true, it is plain that the quality of the protein in the diet is just as essential as its quantity. Indeed, by a judicious mixture of protein feeds, assembled on a basis of their relative amino acid content, it is possible to greatly reduce the actual amount of protein necessary to satisfy the nutritional demands of an animal. The limiting factor in the protein diet of an animal may be the amount of one of the essential amino acids it contains, and if the quantity of one is insufficient, no amount of the others will compensate for this specific deficiency. The best recommendation for the feeder is to use as large a variety of protein feeds as is compatible with economical practice, as variety is the best assurance that the content of the proteins fed will be satisfactory. During the growing period there is greater need for protein and the proportion of protein in the ration should be greater than when the animal is mature. Lactation calls for additional proteins to furnish that which goes into the casein, albumin, and the lesser proteins of the milk. The modern feeding standards specify amounts which are adequate for these purposes.

The importance of mineral matter in the ration is receiving more and more attention as the productive ability of dairy animals increases. In growing animals the construction of new tissue, particularly bones, requires goodly amounts of minerals —especially calcium and phosphorus—and when lactation sets in this demand is increased to supply those same minerals for the milk. In all animals certain inorganic elements as sodium, potassium, iodine, iron, magnesium, phosphorus, etc., are necessary in the life processes, such as contraction of the muscles carrying oxygen in the blood, maintaining neutrality of the blood, conducting nerve stimuli, controlling the functioning of certain glands, assisting in the digestive processes, activating enzymes, and controlling osmotic pressure.

When leguminous hays and such feeds as bran, oats, cotton seed meal, and linseed meal are used liberally, the mineral content of the ration need cause the feeder no concern, except in feeding rapidly growing animals or high producing cows, when it would be well to include finely ground bone, precipitated

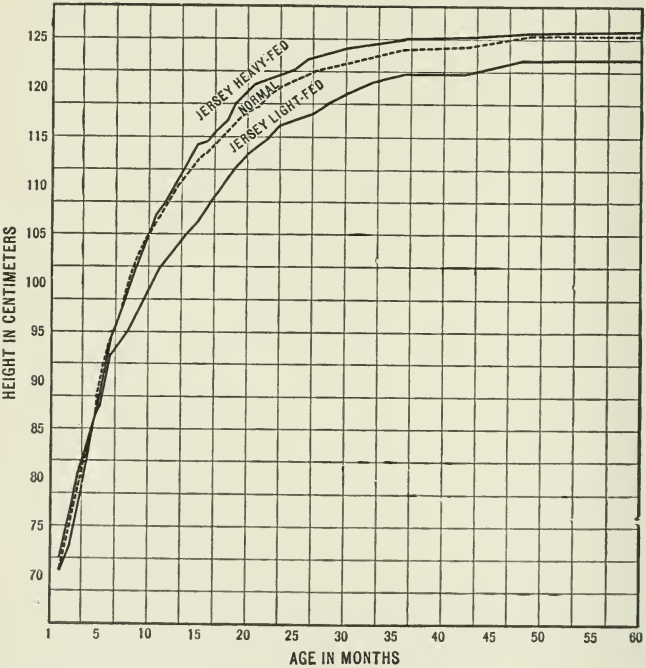


FIG. 52. The liberality of the ration as a factor in determining the skeletal growth of Jerseys

Beginning at 6 months of age when milk feeding was stopped, the light-fed group began to fall below the normal. At five years of age when skeletal growth had ceased they were still undersized. The heavy-fed group were somewhat above normal in size, especially between the ages of 10 and 30 months. At 5 years they were practically normal. Liberal feeding results in rapid growth and allows the animal to reach the full size possible by heredity. Poor feeding may result in the animal failing to grow to the limits of its inheritance.

calcium carbonate, rock phosphate, or some other easily assimilated form of mineral supplement.

We come now to the question of accessory substances or vitamines, of which a great deal still remains undiscovered. It is sufficient to say that these substances are present in many of the common feeding stuffs and there is no reason to believe that when dairy cattle are fed enough to satisfy their demands for growth and production there will be any shortage of either the fat soluble A or the water soluble B vitamines. Besides it is probable the animal is able to carry a reserve supply of these materials sufficient to protect it during a limited period of shortage in the food supply. There is no danger of a shortage while cattle are on pasture.

To all of the above should be added the requirement of palatability. This is secured through the use of a variety of feeding stuffs and those of a succulent nature. Succulent feeds help to maintain the tone of the bowels, and in this class are included pasture grasses, silage, roots, green feeds, and beet pulp. It is well to avoid a ration drawn from a single plant source. A satisfactory balance of bulky and concentrated feeds is maintained by allowing the animal as much roughage as she will consume and feeding grain in proportion to her requirements for growth and milk production. Grain rations should always be made to include some bulky feed, such as bran, to promote better mastication and digestion.

Liberality of the Ration. It is a well-known fact that the rate of growth of an animal is dependent to a considerable extent upon the amount of nutrients received. Observant stockmen have long known that the time of maturity of an animal is hastened by liberal feeding and delayed by scant feeding. It is also a common, although not universal, belief among stockmen that liberal feeding of the young animal results in a larger animal at maturity. Concerning this point probably the correct view is, that with sufficient feed it is possible for the animal to grow to the full extent of its inheritance, while insufficient feed may cause the animal never to reach the full development made possible by its inheritance.

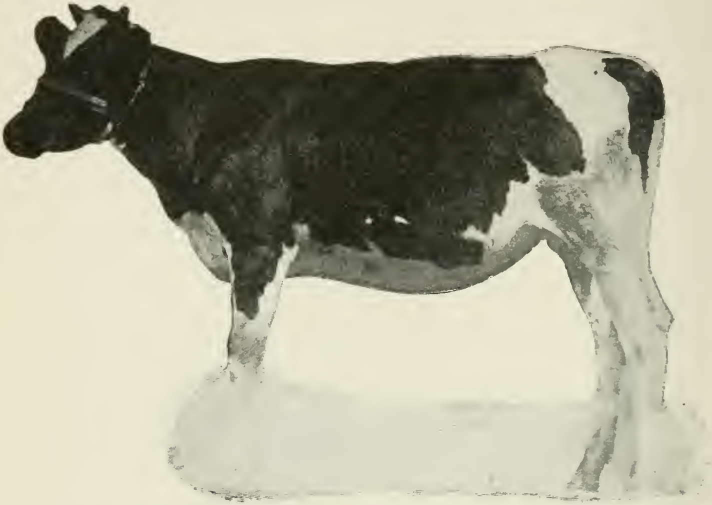


Fig. 53. The influence of the ration upon the size and conformation

This Holstein heifer, one year old, weighs 396 pounds which is 70 per cent of the normal. Height at withers 42.3 inches. She received skim milk and hay—no grain. Compare with Fig. 54.

An experiment conducted at the University of Missouri, in which a total of 39 pure-bred heifers of the Holstein, Jersey and Ayrshire breeds were used, represents the most extensive investigational work conducted under close observation to determine the influence of liberality of the ration and age at calving on the rate of growth and size of dairy heifers. The results bearing on the effect of the liberality of the ration on skeletal growth and weight are given in an abridged form in Table 42. Complete data are set forth in Research Bulletin No. 31 and Bulletin No. 135 of the Missouri Experiment Station.

What are termed the heavy-fed groups received whole milk and practically all they would consume of a grain mixture composed of corn and oats, with alfalfa hay for roughage. The light-fed group received skim milk during the first six months and alfalfa hay, and in some cases pasture, but no grain up to the time of first calving. After calving, both received the same ration which was the one fed to the milking cows in the herd. There seems no doubt that all requirements of ration for growth were met in both groups, and that the only difference of importance was in the total nutrients.

TABLE 42. THE EFFECT OF LIGHT AND HEAVY FEEDING ON HEIGHT AND WEIGHT OF HEIFERS

AGE	HOLSTEINS		JERSEYS	
	HEAVY-FED	LIGHT-FED	HEAVY-FED	LIGHT-FED
MONTHS	HEIGHT CENTIMETERS	HEIGHT CENTIMETERS	HEIGHT CENTIMETERS	HEIGHT CENTIMETERS
1	76.7	75.6	70.1	71.6
6	103.4	96.7	92.7	92.3
12	117.8	106.3	108.8	102.5
18	125.4	115.3	116.6	110.6
24	130.1	121.6	121.8	116.3
36	133.7	126.9	125.1	121.9
48	134.9	129.5	125.7	123.0
60	135.9	130.3	125.9	123.0
Total Increase	59.2	54.7	55.8	52.4
AGE MONTHS	WEIGHT LBS.	WEIGHT LBS.	WEIGHT LBS.	WEIGHT LBS.
1	113	104	66	87
6	418	292	248	245
12	659	404	463	363
18	891	569	708	495
28	1,036	745	842	664
40	1,070	883	884	743
54	1,119	968	907	822
66–78	1,265	1,113	975	851
78–90	1,191		1,006	922
Total Increase	1,078	1,009	940	835

The sudden spread in growth between the heavy- and light-fed groups at about the age of 6 months can be attributed to the fact that milk was dropped from the ration at this point, and the light-fed group from then on received roughage only until first parturition.

The difference in the height of the two groups increased gradually until the maximum was reached at 19 months for both Jerseys and Holsteins. From this point the difference becomes less marked. The figures show that the heavy-fed groups more nearly approached the normals for the breeds. The light-fed groups, because of the feed which they received when young, never reached the normal size. This bears out the fact that the conditions of nutrition during growth may result in the size

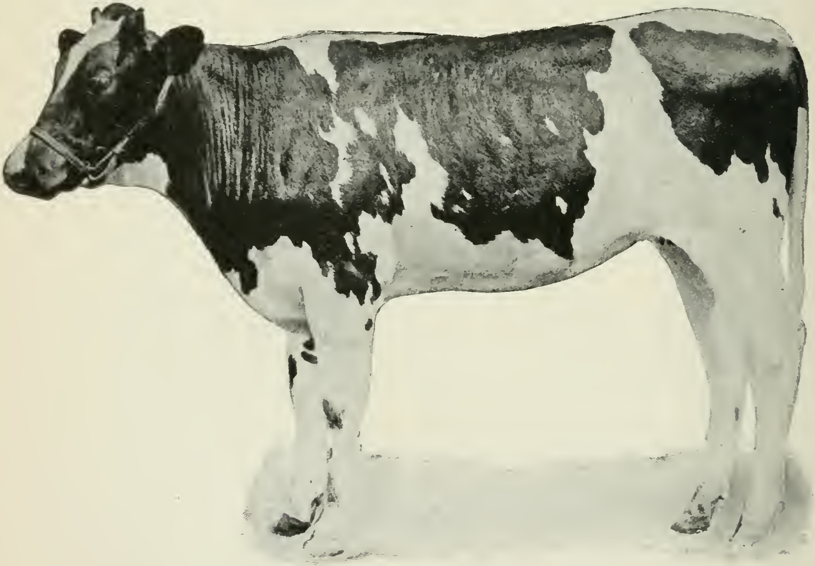


Fig. 54. Influence of ration upon the size and conformation

This Holstein heifer, one year old, and half sister of the one in Fig. 53, weighs 730 pounds which is 130 per cent of the normal; height at withers 48.2 inches. She received whole milk to six months and all the grain and hay she would consume. Compare with Fig. 53. The practicable course is between these two extremes.

at maturity being below normal; and that high nutrition increases the rate of growth to a considerable extent, but cannot stimulate growth beyond the maximum inheritance of the animal.

The amount of digestive nutrients consumed during the growing period has some effect upon the rate of growth of the skeleton, but the relation to the weight is much more pronounced. A ration supplying a large amount of readily digestible nutrients increases the rate of growth, especially in weight; hastens the time of maturity; and allows the animal to develop to the full limit of its inheritance. The animal which receives fewer nutrients in its ration during the growing period is thinner in flesh; and if the plane of nutrition is decidedly lower, the rate of skeletal growth is also slower, the growth period being somewhat prolonged; and the tendency is for the animal at maturity to be smaller than the one raised on a liberal ration.

The most pronounced result of a very liberal ration when the animal is young is earlier maturity. While the tendency is strong to prolong the period of growth by the animals on a ration insufficient for normal growth, there is unquestionably a limit beyond which this will not go. An animal kept for the entire period of normal growth on an insufficient ration will not pro-

TABLE 43. HEAVY RATIONS AND LATE CALVING VERSUS LIGHT RATIONS AND EARLY CALVING

AGE	HEAVY-FED LATE-CALVING JERSEYS, HEIGHT	LIGHT-FED EARLY-CALVING JERSEYS, HEIGHT
MONTHS	CENTIMETERS	CENTIMETERS
6	94.7	93.1
9	105.0	97.9
12	110.6	103.9
18	117.1	110.3
24	122.0	114.0
30	124.6	116.1
36	126.1	118.9
48	126.9	120.6

long its growing period sufficiently to reach normal size for the breed. Clearly one cause for the marked difference in size of the cows of the same breed as found in different herds is the factor of the ration when young. To obtain the most rapid growth, it is necessary to supply a considerable proportion of the nutrients in the form of concentrates. Where roughage only, even if of the best quality, is fed to growing dairy animals, the growth is certain to be much slower than when considerable grain is fed in addition.

Influence of Age at First Calving. The effect of gestation and lactation on the growth of heifers has already been discussed. As the rate of growth decreases with age, it follows that early calving throws the strain of lactation with its growth-retarding influence on the heifer before she has attained sufficient size, and as lactation is an almost continuous function, she is seldom afforded a later opportunity to overcome this check. On the other hand, the late-calving heifer reaches a period when growth is normally slower before her system is taxed by the strain of milk production. These facts are borne out by the figures previously given. Since early calving, with the resulting lactation, tends to reduce the size of the mature animal, the breeder's problem is to determine the relative economy of loss of production through late calving or decreased size of the cow.

Combined Effect of Lactation and Nutrition. Two factors stand out prominently as exerting an influence on growth and determining the size at maturity. They are liberality of the ration and age of first calving. By combining liberal feeding with late calving we afford the animal optimum conditions for quick and maximum growth. On the other hand, a combination of early calving with light feeding in any individual is bound to result in slow development and the mature animal will be undersized. Data showing the result of this combination of factors are given in Table 43 and are illustrated by Fig. 55.

Beginning at practically the same point at 6 months there was a constantly increasing difference in measurement up to 30 months. The margin decreased somewhat after this time

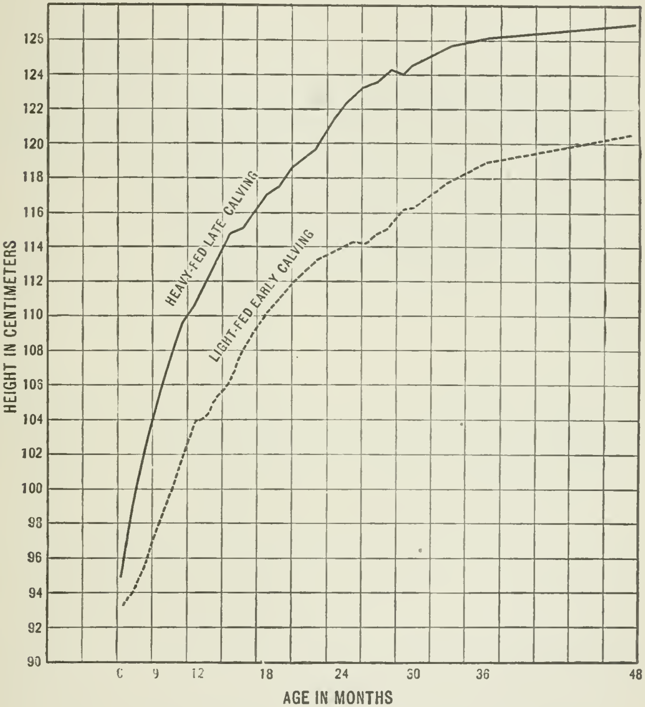


Fig. 55. The combined influence of light feeding and early calving upon skeletal growth of Jerseys

The light-fed, early calving group was 1.6. cm. below the other at 6 months while at 48 months, when skeletal growth for Jerseys is practically complete, the difference was 6.3 cm. The combination of these two factors is a common cause of small cows frequently found in commercial herds.

although at maturity there was still a difference of 6.3 centimeters in height, or about 20 per cent in total gain in height from the time the animals were 6 months old. It should be kept in mind also that the light-fed early-calving group which fell so far behind in growth development, received an ample ration after first parturition. Had the ration been deficient either in quantity or quality during the lactation it is certain that the results would have been even more marked. While hereditary characteristics may in some cases be limiting factors in explaining the numerous undersized cows seen on many farms, it is believed that the most important factors are a combination of early calving and a scanty ration during the growing period. While heredity is a factor in placing a high upper limit to the size of the large animals observed in some herds it is quite certain that, as a rule, a combination of rather late calving and liberal feeding while the cows are young are the more important factors.

Resolving this down to a case of individuals, heavy-fed, late-calving cow No. 53 and light-fed, early-calving cow No. 39 measured as follows:

No.	Class	Height at 48 Mo.	Weight after Second Calving
		Inches	Pounds
53	Heavy-fed, late-calving	53.4	1,122
39	Light-fed, early-calving	47.3	720

Heredity plays no part in these results, as both animals had the same sire, and their dams were half sisters, the dam of 39 being a larger cow by 150 pounds than the dam of 53.

Recovery from Retarded Growth. There is some difference of opinion as to whether or not an animal ever fully recovers from the effects of a period of restricted growth. Not knowing in advance the exact limit an individual would reach under favorable circumstances, we must rely on the average size attained by groups of animals under varying conditions. It would appear that the age at which the check occurs, the duration of the period of limited growth, and the severity of the circumstances causing the suspense would all bear on the ultimate recovery. Since the growth impulse is strongest at an early age and retards as maturity is approached, it seems reasonable that stunting of young animals during the normal period of most rapid development is more apt to have a permanent ill effect.

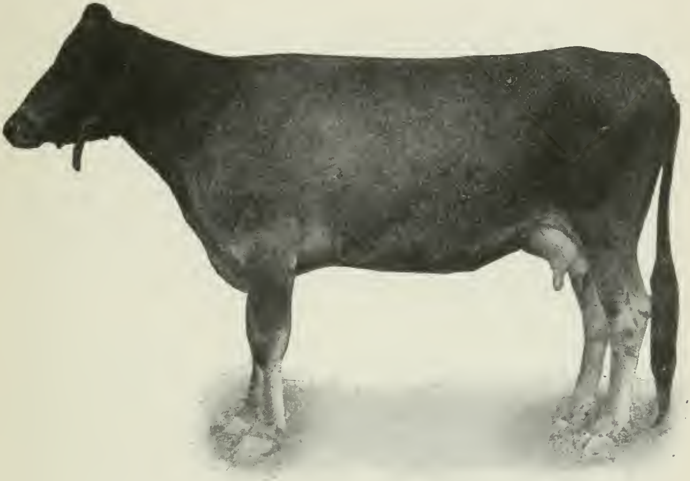


FIG. 56. Influence of age at first calving upon size

Jersey cow, 4 years old, weight 701 pounds, height at withers 47 inches. She was raised on a ration of skim milk and hay and calved at 22 months of age. As the result of the two factors, a light ration and early calving, she was very small at maturity. Compare Fig. 57.

Observation has shown that there is a strong tendency to compensate for adverse conditions which have retarded the growth of the animal and kept it below the normal. There are two ways in which recovery may take place: (1) by an increase in the rate of growth after the period of adversity is past and (2) by prolongation of the period of growth. When an animal which has been retarded because of an inferior ration is given an ample ration, the tendency is strong to use a very large amount of food and to make a growth in excess of the normal rate; and in this manner again to approach the normal size for the breed and age represented. On the other hand, an animal which has made growth above the normal because of a very liberal ration shows a marked retardation when the conditions become less favorable. Conditions which may cause a growth above normal for a growth of animals under low conditions of nutrition may cause a growth below normal for a group that is above normal as the result of a period of high nutrition.

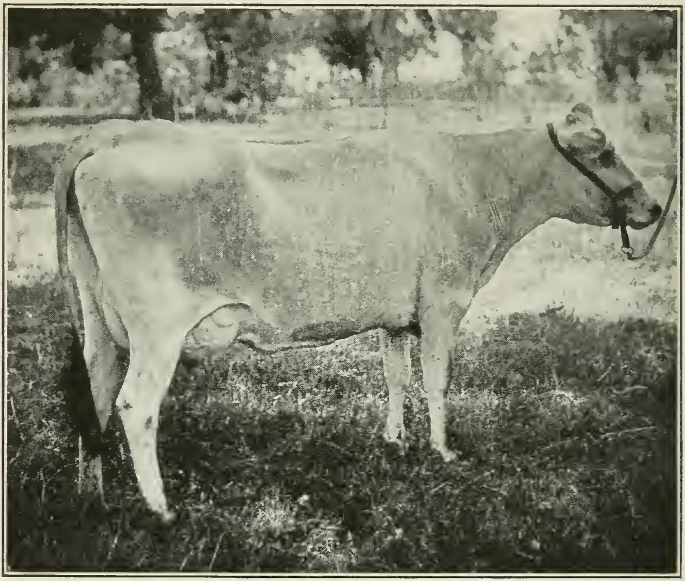


FIG. 57. Jersey cow, 4 years old, weight 876 pounds, height at withers 49.1 inches

This cow, a half sister of that in Fig. 56, received the same ration but did not calve until 35 months old. As a result of the later calving she weighed more than 100 pounds more at maturity than her half sister that calved young.

The second method of recovery from stunted condition is by a prolongation of the period of growth. The heavy-fed animal reaches a comparatively early maturity. The light-fed animal grows more slowly and for a longer period of time until a more advanced age has been reached. In some cases the light-fed animal may completely recover when placed on a more liberal ration.

There is a strong tendency for animals to recover from retarded growth but if the retardation, especially in skeletal growth, has gone too far the animal will not reach the normal size.

There is still some doubt as to whether or not stunting has any deleterious effect on the animal's later welfare. It is well to bear in mind that in rearing dairy heifers we are dealing with animals that will prove most profitable when their early care and handling is such as to insure full development of the body and vital organs. The production of milk throws an enormous strain on the cow, and any preliminary system of management which would impair the proper functioning of her power to reproduce herself and to elaborate milk in generous quantities would in the end result in loss to the breeder.

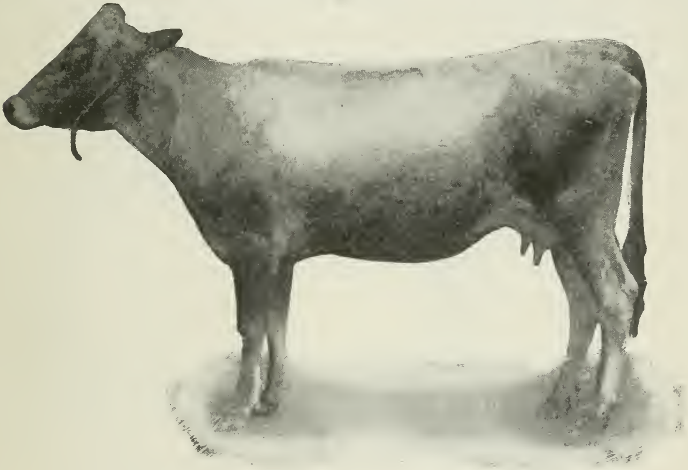


FIG. 58. The combined effect of early calving and light ration

This Jersey cow, 3 years old, weight 622 pounds, height at withers 46.1 inches, was raised on skim milk and roughage and calved at 23 months. Her small size at maturity was the result of the combination of the two factors, early calving and light feeding. This combination is the most common cause of the small animals seen in many commercial herds.

Cause of Milk Secretion. In order to fully appreciate what effect, if any, the early growth and development of a heifer will have on her capacity to produce milk, it is necessary first of all to consider the cause of milk secretion. We are again dealing with one of those natural phenomena of which our present knowledge is very limited. Like the impulse to grow, the stimulus to give milk is believed to be due in the first instance to hormones or internal secretions. The functioning of the mammary gland ordinarily begins at the time of calving. Even in the case of cows that milk continuously from one lactation period to another, there is a fundamental physiological disturbance of the regular functioning of the gland at or about the time of parturition, and a decided change in the composition

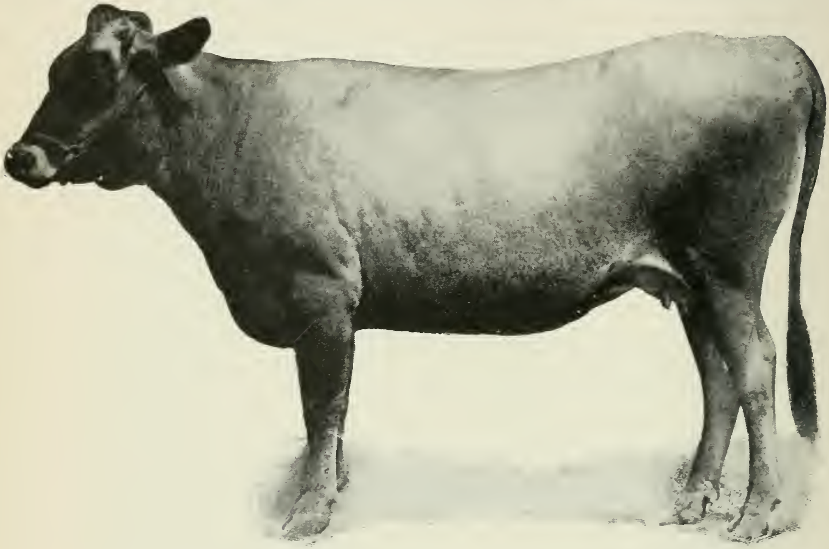


FIG. 59. The combined effect of late calving and a heavy ration

This Jersey cow is three years old, weight 1,194 pounds, height at withers 53.1 inches. She calved at 37 months. Her unusual size is largely the result of receiving whole milk to six months of age and all the grain and alfalfa hay she could consume to maturity. Compare with Fig. 58. The practical procedure is between these extremes.

of the milk. It is true that there are cases on record of precocious heifers which started to produce milk long before calving; but it is possible that stimulation, such as being sucked by herself or other calves, may set up the act of milk secretion in a heifer. Again, it is possible that an abnormal or diseased condition of the reproductive organs, which prevents conception, may also release the instrument of internal stimulation and cause the mammary gland to function.

The source of the specific hormone which is responsible for lactation is not definitely known. It is believed by some authorities to come from the corpus luteum, or yellow body, which forms in the follicle of the ovary after the ovum is expelled, and which persists when conception occurs. Other physiologists contend that the act of milk secretion is set in motion by secretions from the fetal membranes at the time they are released from the uterus and expelled with the calf. It has also been said that the fetal membranes act as a storehouse for the secretion of the corpus luteum.

Regardless of its source, there is evidence that a powerful force is at work, and its intensity, is, of course, variable with the individual. The stimulation to produce milk is an inherited quality, and in cows of high milking tendencies it is so insistent that the animal in early lactation will continue to give milk even at the expense of her body tissues when the supply of nutrients in the ration is insufficient for both milk and bodily maintenance. Starting at the time of parturition this internal force continues in effect throughout a varying period of time, depending on the individual and her breeding. In good dairy cows it is working at its maximum power for three or four months and then gradually diminishes until it is entirely spent, when the cow will ordinarily dry up if the act of milking is discontinued. Coincident with this internal factor, the mammary gland receives an external stimulus at regular intervals by the act of milking and handling and massaging the udder. It is this external stimulation which prolongs the lactation after the internal force has died down.

Liberal feeding of cows of the dairy breeds enables them to attain the limits of the productive ability which they inherit, but it cannot be set down as a cause for milk secretion. If it were, then beef cattle could be fed to produce large quantities of milk, but their use of liberal feed is to make beef.

Relation of Size of Cow to Total Milk Production and Economy of Production. As has been seen from the foregoing paragraphs, it is possible by a system of feeding and herd management to influence the size of the animals in the herd. For this reason it is well to know what relation the size of the cow bears to her total milk production and also if small, medium or large cows are most economical producers.

In general, those keeping cows to produce dairy products for sale prefer a cow medium to large for the breed. Most breeders have the same preference, but some, especially those breeding the smaller breeds, do not favor an animal that is large for the breed, and they often look with more favor upon the smaller types. The cows that have made the largest milk and fat records have without exception been large animals for their breed. Woll[1] has also shown that the highest production is found with cows that are large for the breed to which they belong. The stimulation to give large quantities of milk may be inherited entirely independent of size, and an undersized cow with a great stimulation to give milk is limited by her capacity to digest feed and cannot compete with a larger cow that has inherited the stimulation to give milk to a high degree and has the capacity and strength to handle the feed necessary for high production.

From the standpoint of economy in production, what is wanted is sufficient size to support and supply nutrients for the milk-producing system which the cow has inherited. Large size is only of advantage when combined with a strong stimulation to produce milk; otherwise it in itself is an additional drawback to economical production because the requirement for maintenance varies directly with the size of the animal.

---

[1] F. W. Woll, Proceedings, Society for Promotion of Agricultural Science, 1912.

Influence of Ration During the Growing Period on Dairy Qualities and Type. There is a more or less general belief among breeders that if a heifer is fed a ration of such a character that she becomes fat before maturity a tendency is developed towards using feed for body fat which will persist when the cow is mature and in milk, and that the animal will become larger and coarser than if fed a less liberal ration. However, this opinion is not shared by all breeders, particularly those men who condition heifers for official records.

Inheritance is such a dominant influence in milk production that it interferes with our studies of the feeding factor. If a cow is kept fat during her growing period and proves to be a poor producer, we cannot say she would have given more milk if her ration had been less liberal while she was growing. Most likely her inherited capacity was at fault. Because of this uncertainty we cannot place too broad an interpretation on the results of feeding experiments.

In comparing the production of light- and heavy-fed groups of animals, it is well to remember that in the first lactation period the latter have a decided advantage on account of being in much better physical condition. If, however, excessive fat is detrimental to a dairy heifer this might be a disadvantage, but it is a well-known fact that mature dairy cows are at their best for milk production when in high state of flesh at calving time. After the first lactation period both groups of heifers under consideration received similar feed, and since we are concerned with the ultimate capacity of the cows, a comparison of second lactation periods will serve our purpose better. Table 44 gives the production of light- and heavy-fed groups during the second lactation period.

TABLE 44. MILK AND FAT PRODUCTION—SECOND LACTATION PERIOD

GROUP	BREED	NUMBER	LBS. MILK	LBS. FAT
Light Fed	Jersey	10	5,369	285
Heavy Fed	Jersey	8	4,393	228
Light Fed	Holstein	7	7,699	229
Heavy Fed	Holstein	8	7,246	227
Light Fed	Ayrshire	2	5,864	236
Heavy Fed	Ayrshire	2	5,772	229

It will be noted that the ten light-fed Jerseys averaged 285 pounds of fat, while eight heavy-fed averaged 228 pounds. The Holstein and Ayrshire figures, while both in favor of the light-fed, are so close as to be of no special significance.

In the entire experiment, the nineteen light-fed heifers averaged 258 pounds of fat for their second lactation period, while the eighteen heavy-fed animals averaged 227 pounds. It might be of interest to state that out of eighteen animals in the heavy-fed group, eight were sold as being below the standard of the herd after the experiment was completed, and of the nineteen light-fed heifers, five were considered below standard.

After considering all the data fully and analyzing the results as fully as possible, we come to the conclusion that some detrimental effects followed the excessively heavy ration fed the Jerseys—and possibly, to a slight degree, the Holsteins and Ayrshires as well. However, some of the best cows, as evidenced by their subsequent production, were in the heavy-fed groups. At any rate heavy feeding does not necessarily injure a cow, even if excessive and prolonged to the age of three years before first calving. In ordinary feeding practice this factor is not one of very great importance. Our data would justify the conclusion that the great variations in milking quality of dairy cows as found in ordinary herds is not to be attributed to any extent to the possibility that they were overfed when young. The supposition by breeders that heavy feeding when young is detrimental to the milking functions of the mature cow is based upon observation which may be erroneous. When a cow of a dairy breed lacks in dairy qualities, and shows beef tendency in conformation, it is easy to attribute it to over feeding when young. In most cases the same animal showed a beef conformation when young, not from over feeding, but as an inherited characteristic. The data which have been given add strength to the general conclusion that heredity is the chief factor in determining the extent of the development of the milk-producing function of cows.

The word type as used in this connection refers to conformation of the animal as judged by ordinary standards of the breed represented. The standard to be used as a basis of comparison is the score card for the breed in question.

The effects of feeding on the type of the animal can best be studied from the illustrations given. Figures 56, 57, and 58 show the mature appearance of cows raised on the light ration. Figures 54 and 59 are cows that received the heavy ration during the period of growth. The question of dairy type is closely connected with the size of the animal. Attention has already been called to the more rapid growth and larger animals which resulted from the more liberal ration, and it was observed that the animals receiving the heavy ration showed a coarseness of bone not found in those receiving the lighter ration. The coarseness described was most apparent in the head.

It has been believed by some that a heifer raised on a ration composed mostly of roughage, as was the case with our light-fed group, would have more depth of barrel than an animal that had received a ration composed largely of grain. This difference was plainly seen during the time the animals were receiving the experimental rations. The heavy-fed group had more of the characteristics of fattened steers. They were smooth and round in body, with top and under lines almost parallel. They did not show the paunch development which characterizes heifers of dairy breeds fed upon ordinary rations. The light-fed group, on the other hand, appeared quite angular in body with a far more pronounced development of the middle. As might be expected, the heavy-fed group, as heifers, were smoother than typical dairy heifers in good herds, and the light-fed group were more angular and had large bodies; but as mature cows, the heavy-fed animals show no special deficiencies in barrel as compared with those raised on the light ration. It was found that the heavy-fed animals began to show more angularity beginning about three months before calving, and by the time calving occurred considerable of the round appearance of the body had disappeared and they began to take on the look of a typical dairy cow.

The inherited conformation of the animal is undoubtedly a factor, also, but the evidence admits of the conclusion that the size of the barrel of the cow when mature has no relation to the character of her feeding when in the growing period. A ration giving an abundance of nutrients in an easily digested form results in more rapid growth and a tendency to coarseness of bone and body, which is not lost with a change of ration when mature. On the other hand, the roundness of body induced by a heavy ration disappears at about the time of calving.

Influence of Age at First Calving on Dairy Qualities and Type. The question of the relation of age at first calving to the milking function may be discussed from two points of view. How does it affect the maximum productive capacity of the cow? And what difference in the total or life-time production of the animal will result by delaying breeding for several months or a year?

Because of factors, such as inheritance, which interfere with a strict interpretation of the results obtained with limited numbers of experimental animals, and the further difficulty of deciding on a fair basis of comparison of the early lactation periods, it would seem that the best answer to this question can be drawn from the records of a large herd of animals kept over an extended period of time. A summary of the records of 70 Jersey and 25 Holstein cows in the dairy herd owned by the University of Missouri, for a period of over 20 years, shows that with both Jerseys and Holsteins the highest producers were those well mature at first calving. The Jerseys calving under 20 months averaged 207 pounds fat for the first three lactation periods; those calving at the age of 24 to 30 months averaged 260 pounds; and those between 28 and 32 months, 328 pounds. The Holsteins calving under 24 months old averaged 225 pounds fat for the first three lactation periods; those calving at 24 to 30 months averaged 307 pounds; and those calving at 30 to 36 months, 266 pounds. These figures lead to the conclusion that from the standpoint of securing the greatest development as a dairy animal it is a decided disadvantage for a Jersey cow to calve under 24 months old, while nothing seems to be gained by allowing her to reach an age of more than 30 months. It would also appear that the best Holstein milk producers are on the average found among those which are well matured before coming into milk for the first time.

Taking into consideration the question of economy, it would appear that a medium course would be the best to pursue. The point at which the heifer is sufficiently mature to come into milk to advantage will depend to a considerable extent upon the ration during the growing period. An animal receiving a liberal grain ration is as mature at 24 months as one raised on hay alone is at 30 months.

The question of type, as before stated, is quite closely connected with size, and there is a general belief that early calving tends toward a more refined feminine type of animal. As has already been demonstrated, early calving has the most potent influence on size; and measurements and observation of the experimental animals showed that in most cases cows that had calved at the age of 20 to 24 months had a more refined feminine appearance and were smaller in size than those of the same breed calving a year later. While no attempt was made to apply the score card to the breeds represented, it is believed that on the average those calving at an early age would have scored some higher after maturity was reached. This statement refers especially to those characteristics of the animal not connected with the udder and milk veins. The development of the milking organs, so far as size and shape are concerned, did not seem to bear any relation to the age at first calving.

Factors Influencing the Age of Sexual Maturity. Having seen that heavy feeding hastens the growth and induces earlier maturity, it is natural to assume that the ration would likewise influence the age at which the heifer first comes in heat. It is known that under extreme conditions when the ration is deficient in some essential food substance the first appearance of heat is delayed from 3 to 6 months. The effect of heavy feeding is to advance the age of sexual maturity, and in trials already discussed the heavy-fed Holsteins reached this stage of development at an average age of 261 days, while the light-fed group averaged 373 days, a difference of 112 days. The heavy-fed Jerseys were sexually mature on an average 76 days earlier than the light-fed Jerseys.

Influence of the Ration on Breeding Qualities. It is thought by some that when young heifers are fed to the point of being excessively fat that difficulty in breeding will follow. A study of the breeding records of these experimental animals indicates that even where the conditions were extreme there was little effect upon the reproductive function. It should be borne in mind, however, that the same might not hold good in the case of older cows that are allowed to become fat.

Conclusion. As a general conclusion to this chapter, it can be said that it is possible to influence the rate of growth, size when mature, and type—to some extent—by the liberality of the ration during the growing period, and the age at first calving. The character of the ration with reference to amount of nutrients supplied does not exert any appreciable effect upon the milking functions of the cow when mature. The age at first calving is a factor of some importance with reference to the development of the milking function in the cow. Calving at an extremely early age is detrimental to the best development of the milking function, while nothing is gained by too great delay.

CHAPTER XIX

RAISING THE DAIRY HEIFER

Previous chapters on calf feeding have outlined various systems of feeding and management for young dairy stock up to the age of weaning, which in ordinary practice is six months. Emphasis has been laid on the wisdom of raising cows to replenish the milking herd. The question of economy always enters into a carefully planned method of carrying heifers through the non-productive period from birth to first calving. The preceding chapter calls attention to the factors which are most active in influencing the growth and development of dairy heifers, and these should receive thoughtful consideration in planning a system of herd management for the young stock.

Use of Normal Growth Figures. The average breeder relies on observation as his means of measuring the growth of heifers, and men with experience are able to develop animals according to their own standards by watching the response to the quantity and character of the rations they feed. Feeders with less experience, and even those who are close observers, will find a helpful guide in the normal growth figures shown in Tables 39 and 40. If a stock scale is included in the farm equipment it does not require a great deal of time to weigh a group of heifers once a month, or even at longer intervals during the press of outdoor work. This will afford an accurate check on the growth of the heifers by comparing them with the normal size for the age, and will tend to develop the beginner's powers of observation, and afford a satisfactory confirmation for those of the veteran feeder. The use of scales is especially helpful with young calves.

For convenient reference the normal weight tables are repeated in abridged form in Table 45, showing the daily rate of gain.

Table 45. Normal Weights and Gains of Dairy Heifers

Age	Holstein		Jersey		Ayrshire	
	Normal Weight	Av. Daily Gain	Normal Weight	Av. Daily Gain	Normal Weight	Av. Daily Gain
Mos.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
6	349		260		285	
9	466	1.3	376	1.3	366	0.9
12	558	1.0	456	0.9	456	1.0
15	612	0.6	520	0.7	547	1.0
18	686	0.8	572	0.6	604	0.6
21	774	1.0	649	0.9	679	0.8
24	841	0.7	716	0.7	759	0.9

Feed and Care of the Heifer after Weaning. One mistake often made in handling calves after weaning is to discontinue both milk and grain feeding at the same time. This treatment is often given fall calves which have been barn fed on milk and grain through the winter and are turned out on fresh pasture in the spring to rustle for themselves. If good results are looked for, this mistake should be avoided, as the young animals have not developed the capacity to eat and digest a sufficient quantity of bulky feed to sustain normal growth, and grain feeding to supplement the pasture grass should be continued some time after milk feeding is stopped. It is also a wise precaution to limit the time on pasture the first few days until the calves become accustomed to the change of feed. Calves which have been eating a liberal allowance of hay before they are turned out will readily accommodate themselves to a grass diet; but early spring pasture grass is made up largely of water and the grain which is fed in addition will pay well in increased growth.

Spring calves which are weaned in the fall after pasture season should have the same consideration with regard to grain feeding as is recommended for fall calves, but roughage should be fed up to the limit that the animal will consume. The roughage should by all means consist mostly of some legume, as clover, alfalfa, cow-pea, or soy-bean hay, on account of the palatability and high protein and ash content of these feeds. Corn silage is also well adapted for part of the ration, but should always be combined with some leguminous hay or with a ration of grain that supplies ample material for growth, such as linseed meal or cotton seed meal.

Ordinarily the period from weaning to first calving is about eighteen months to two years, and this represents two seasons of winter feeding and two seasons on pasture, or two of one and one of the other. Where pasture is available, it presents the most economical means of growing heifers; and the influence of winter feeding on subsequent growth on grass should enter into the plan for raising heifers most economically and satisfactorily.

In most localities where dairy cattle abound there is a pasturing season during the year, and for this reason the problem of feeding heifers is mainly one of winter feeding. The rations here suggested were fed experimentally to the heifers in the herd at the University of Missouri, with a view to determining their relative efficiency to produce satisfactory growth and to studying the comparative economy of their use in wintering young stock. The data include figures and observations on 76 animals, and show the results of wintering experiments during five years. The complete information is set forth in Bulletin 158 of the Missouri Experiment Station.

Tables 46, 47, and 48 are so arranged that one shows the results from rations made up of legume hays with or without grain; another, the results from rations of silage with grain and timothy hay; and the third, the results from various combinations of silage and alfalfa, with and without supplementary grain.

Table 46. Results from Legume Hay Alone and with Grain

Ration	Group 1	Group 2	Group 5	Group 9	Group 4
	Alfalfa Only	Alfalfa Only	Alfalfa at will 2 Lbs. Corn	Alfalfa at will 3 Lbs. Corn	Clover at will 3 Lbs. Corn
Length of Trial, Days	150	150	150	150	150
Av. Age at Beginning, Months and Days . .	11–25	10–14	11–13	12–10	11–4
Average Feed Consumed Daily Lbs. Alfalfa	11.9	13.4	13.4	11.5	
Clover					
Grain			2.0	3.0	3.0
Av. Daily Gain, Lbs.	0.51	0.76	0.97	0.85	0.85
Normal Daily Gain, Lbs. . .	0.77	0.95	0.83	0.79	0.78
Total Gain in Height, Centimeters	5.5	7.5	8.2	6.2	7.2
Normal Total Gain in Height, Centimeters .	6.6	7.4	7.8	4.6	7.5

Alfalfa Alone and with Grain Supplement. Table 46 clearly indicates that the use of alfalfa alone for growing heifers will not produce normal growth as measured by body weight and height. Only 2 animals for the 17 made the normal gain in weight.

The amount of protein in the alfalfa consumed was considerably in excess of the feeding standard requirements, and this was not the limiting factor. Although alfalfa is probably the most palatable roughage used for cattle, the failure of these animals to make normal gains was due to their inability to consume a sufficient quantity to supply the energy needed.

To supply the deficiency a home-grown grain is the logical feed to supplement the alfalfa, unless silage is available. The amount of grain to feed will depend somewhat on the palatability of the hay. Groups 5 and 9 in Table 46 both made satisfactory gains and better than normal growth, and the additional pound of corn received daily by Group 9 resulted in a lower daily consumption of alfalfa. The relative prices of these two feeds should be considered, but when both are farm grown, two pounds of corn would be preferable to three, as this is a concentrate which can also be utilized for pork production.

Group 4 shows that clover hay may be used satisfactorily in place of alfalfa, and it is reasonable to assume that cow-pea or soy-bean hay of good quality will serve as well.

TABLE 47. RESULTS FROM SILAGE AND GRAIN, OR SILAGE, HAY AND GRAIN

	GROUP 3	GROUP 6	GROUP 10	GROUP 13
RATION	Silage at will 1 Lb. Corn 1 Lb. Cottonseed Meal	Silage at will 2 Lbs. Timothy 1 Lb. Corn 1 Lb. Cottonseed Meal	Silage at will 2 Lbs. Timothy Mixture of half Corn and half Cottonseed Meal	Silage at will Timothy at will Corn enough to make gain of ¼lb. daily
Length of Trial Days	150	150	150	150
Animals Used .	2 Jersey 1 Holstein	2 Jersey 2 Holstein	2 Jersey 2 Holstein	1 Jersey 2 Holstein 1 Ayrshire
Average age at Beginning Mo. and Days	11–13	12–26	11–19	9–21
Av. Feed Consumed Daily Lbs. Silage	18.9	20.6	12.4	13.8
Av. Feed Consumed Daily Lbs. Timothy		2.0	2.0	3.3
Av. Feed Consumed Daily Lbs. Grain	2.0	2.0	3.2	0.65
Av. Daily Gain, Lbs.	0.71	0.82	0.76	0.35
Normal Daily Gain, Lbs. . .	0.77	0.77	0.83	0.82
Total Gain in Height, Centimeters . . .	7.0	7.9	6.0	7.8
Normal Total Gain in Height Centimeters .	7.7	6.1	6.9	9.3

Use of Silage in Winter Rations for Heifers. Table 47 is a summary of the results obtained by the use of silage with grain or timothy, hay, and grain. While it is possible to maintain dry cows in good condition on silage alone, the growing animal requires more protein than is contained in the maximum quantity of silage it can consume. Group 3 received a grain supplement of 2 pounds of corn and cottonseed meal, half and half, but they were unable to eat enough silage to bring the daily consumption of protein or energy up to the feeding standard requirements. This accounts for their failure to make normal increase in weight or height. The addition of two pounds of timothy to this ration gave more satisfactory results, as evinced by Group 6, but while the energy deficiency was overcome there was still a shortage of protein in the ration. The addition of timothy hay caused no decrease in the quantity of silage consumed.

Group 10 received on the average more grain than Group 6, but they fell considerably behind in the amount of silage eaten. They were more than a month younger than Group 6—which emphasizes the need of more grain in proportion to roughage for the younger animals.

Group 13 were fed so as to gain only about one-fourth pound daily, and cannot be compared with the others but serve to emphasize the fact that silage and timothy will not produce normal growth in animals even when more than one-half pound of grain a day is fed in addition.

The results show that silage may be used for the growing heifer but has decided limitations, largely on account of the low protein content and its bulky nature. The low mineral content of this roughage in comparison with legume hay is also a point of considerable importance.

The main problem is to supply a ration of such character that sufficient will be consumed to insure the necessary amount of digestible nutrients and that the protein will not be lacking.

TABLE 48. RESULTS FROM RATIONS OF SILAGE AND ALFALFA, WITH AND WITHOUT GRAIN

	GROUP 7	GROUP 8	GROUP 12	GROUP 11	GROUP 15	GROUP 14	GROUP 16
RATION	Silage and Alfalfa, Ratio 1 to 3, to limit of appetite	Silage and Alfalfa, Ratio 1 to 3, at will. 2 lbs. Corn	Silage at will. 1 lb. Alfalfa per 100 lbs. live wt. 1 lb. Corn per 100 lbs. live wt.	Silage at will. 1 lb. Alfalfa per 100 lbs., live wt. 2 lbs. Corn	Silage at will. Alfalfa limited to 6 lbs. daily	Silage at will. 6 lbs. Alfalfa, 1 lb. corn daily for animals over 1 yr.; 2 lbs. for those under 1 yr.	Silage at will. Alfalfa at will
Length of Trial, Days	150	150	150	150	150	150	150
Animals used	2 Jersey 2 Holstein	1 Jersey 1 Holstein 1 Ayrshire	2 Holstein 1 Ayrshire	1 Jersey 2 Holstein 1 Ayrshire	2 Jersey 4 Holstein 1 Ayrshire	3 Jersey 3 Holstein 1 Ayrshire	1 Jersey 2 Holstein 1 Ayrshire
Average Age at Beginning Mo. and Day	12–19	17–15	12–13	11–21	12–16	10–18	9–21
Av. Feed Consumed Daily Lbs. Silage	19.2	17.0	15.3	17.8	18.1	13.8	14.4
Alfalfa	6.37	6.0	5.9	5.3	5.8	5.4	6.6
Grain		2.0	6.0	2.0			
Average Daily Gain, Lbs.	0.54	1.12	1.63	1.10	1.03	1.01	1.10
Normal Daily Gain, Lbs.	0.76	0.74	0.86	0.72	0.83	0.85	0.86
Total Gain in Height, Centimeters	7.3	4.8	10.1	10.1	6.4	8.1	9.6
Normal Total Gain in Hgt. Centimeters	6.3	4.7	7.2	7.8	6.1	7.7	8.1

Alfalfa Hay and Silage for Growing Heifers. In Table 48 are shown results secured by the use of silage and alfalfa in various combinations with and without grain supplements. A glance at the weights and measurements is sufficient to prove that the combined use of these two roughages makes a highly satisfactory growth-producing feed for heifers. With the exception of Group 7, all lots increased in weight and height at a rate substantially above normal during the period of feeding trials. The two Jersey heifers in Group 7 for some reason made gains of less than half of normal. There are a total of 15 animals in the three lots fed alfalfa and silage only, and the average daily gain for all was .89 pound, as compared with normal gain of .82 pound. When both are fed at will, the ratio is about two pounds of silage to one of alfalfa, which appears to give better results than a ratio of 3 to 1.

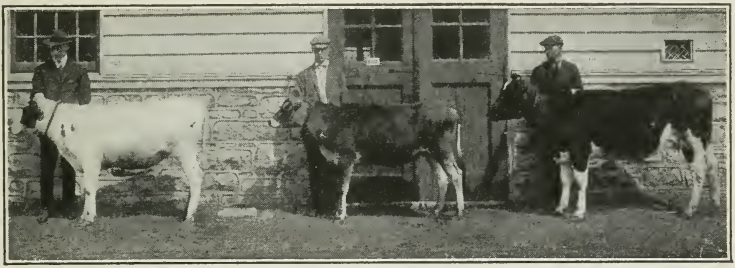


Fig. 60. Heifers wintered for six months on a ration of alfalfa and corn silage

They received as much silage as they would eat and were limited to 6 pounds of alfalfa each daily. Their average consumption of feed was, silage 18 pounds; alfalfa 5.8; the average daily gain 1.03 pounds compared to a normal of 0.83 pound.

Corn was the concentrate used in conjunction with the two roughages. Its addition increased the gains, and when fed liberally it reduced the quantity of silage consumed. Judging from the satisfactory results obtained where alfalfa and silage were fed alone, it would seem unnecessary to add a supplement, except in the case of heifers under 10 months old.

Direct comparison of the Holstein group fed alfalfa alone with the animals of that breed receiving silage and alfalfa shows a daily gain of .76 pound for the former and 1.08 pounds for the latter. Jerseys on alfalfa alone gained .51 pound and those fed silage and alfalfa gained .60 pound daily. In both cases the value of the addition of the silage is demonstrated, and the greater gains are due to increased energy supplied.

Practical Winter Rations for Heifers. From the analysis of the foregoing studies the following rations are recommended according to the conditions prevailing.

1. When silage and legume hay are on hand, or can be pur-

chased economically, the ration suggested is as follows: Corn silage and alfalfa, clover, cow-pea or soy-bean hay at will; and for animals less than 10 months old 2 pounds of grain daily in addition. The grain fed may be corn, or a mixture of other grains if the cost per pound is less. For heifers within three months of calving 2 to 5 pounds of grain should be fed daily, depending upon condition. The object is to have them in good flesh at calving time.

2. When corn silage is on hand, but no legume hay, a satisfactory ration is silage at will for roughage, with some dry feed such as hay or fodder. Two or three pounds of concentrate should be fed daily, one-half of which should be a high protein feed—such as gluten feed, linseed meal or cottonseed meal. The remaining half may be corn, oats, bran, or any other mixture, if cheaper per pound than corn.

3. When an abundance of legume hay, but no silage, is on hand, a satisfactory ration is alfalfa, clover, cow-pea, or soybean hay at will, and 2 pounds of corn daily. Other grains may be substituted with economy if the cost per pound is less than corn. On a ration of legume hay dairy heifers will do fairly well, but will not make a normal growth. It is believed to be economical, as a rule, to feed a limited amount of grain in addition.

4. When corn fodder, or kaffir fodder, or timothy hay is on hand, but no silage or legume hay, it is generally best to purchase legume hay. The suggested ration is legume hay one-half, timothy hay one-half and corn fodder at will. With this should be fed a grain mixture composed of one part gluten feed, or cottonseed or linseed meal, and two parts corn. Other concentrates may be used in place of corn if the cost per pound is less.

If legume hay cannot be purchased, more grain must be fed for even fair results. Under these conditions the ration suggested is: Hay and fodder at will, with five pounds daily of a grain mixture composed of one part corn, one part bran, one part cottonseed meal, linseed meal, or gluten feed.

The palatability and bulkiness of a ration are often the limiting factors in the amount consumed and, as a result, in the gains made. For example, a ration which meets the requirements as laid down by the feeding standard may be formulated from timothy hay and cottonseed meal; but heifers will not make normal growth on such a ration.

Under conditions of feeding as practiced on some farms, especially in the corn belt, the protein in the ration is the factor which limits growth, although normal growth may be obtained from rations furnishing considerable less protein than the feeding standards prescribe. A ration containing a legume hay will seldom be deficient in protein.

Various Concentrates for Supplementing Silage. Experiments conducted by Hunt in wintering dairy heifers furnish some interesting comparisons of protein concentrates used to supplement silage. The roughages fed were corn silage and stover silage. Molasses was added to the latter at the rate of 1 pound to 10 pounds of silage, but on this basis it did not prove equal in feeding value to the normal silage, nor did the addition of 2 pounds of ground corn to 3 pounds of stover silage fully replace the nutrients lost by removing the ears and weathering of the stover in the field.

Fig. 61. Heifers wintered on silage, alfalfa, and corn

They were allowed as much silage and alfalfa as they would eat and limited to 2 pounds of corn each daily. They consumed an average ration of 17 pounds of corn, 6 pounds of alfalfa, and 2 pounds of corn. The average daily gain was 1.12 pounds compared to a normal of 0.74. It is not economical to feed as liberally in a commercial herd.

Silage was fed in quantities varying from 20 to 30 pounds, according to the size of the animals. The following protein supplements were fed in quantities shown daily; cottonseed meal, 1¾ to 2½ pounds; linseed meal, 2½ pounds; soy-bean meal 1½ to 1¾ pounds; peanut meal from hulled nuts, 2 to 2½ pounds; gluten meal, 2½ pounds; nut meal, 3½ pounds; velvet bean meal 3½ to 4 pounds; wheat bran, 5 pounds.

The trials all resulted in satisfactory gains with the exception of one season, when the silage was of only fair quality and the amount of concentrates did not supply enough protein.

For use as supplements for silage in feeding heifers, these feeds are ranked about as follows: Soy-bean meal, linseed meal, cottonseed meal, gluten meal, peanut meal from hulled nuts, cocoanut meal, velvet bean meal, and bran. The first five are about equal in feeding value, but soy-bean meal and linseed meal are moderately laxative and also give the skin and hair a soft glossy appearance. Cottonseed meal and gluten meal are somewhat constipating. It was found that about 3½ pounds of cocoanut meal and 4 pounds of velvet-bean meal were necessary to equal 2½ pounds of cottonseed meal in feeding value in these trials, and that bran was too bulky for satisfactory results when used as the sole supplement for silage.

Quantities to Feed at Various Ages. Table 49 will serve as a guide to the feeder in using standard rations, but attention is called to the fact that heifers under 10 months old should be fed additional grain. The feeding standards in general use provide more protein and energy than is necessary to produce normal growth of dairy heifers past the age of 9 or 10 months. Animals below this age should be fed a sufficient amount of palatable feed to meet the requirements of the standard. Because of the limited capacity of heifers of this age to eat roughage, some of their nutrients must be supplied in concentrated form, which accounts for the recommendation to feed grain to the younger stock.

The period from 12 to 18 months offers no difficulties, and animals of this age will develop satisfactorily on any of the rations recommended. The same is true of the succeeding 6 months period, except in the case of those heifers which are bred to calve at 2 years. They should receive additional grain daily, ranging from 2 to 5 pounds, during the three months prior to parturition.

TABLE 49. AMOUNTS OF FEED CONSUMED AT VARIOUS AGES

RATION	JERSEYS				HOLSTEINS			
	Silage	Alfalfa	Corn	C.S.M.	Silage	Alfalfa	Corn	C.S.M.
	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.
6 TO 12 MONTHS								
Silage at will* 1 pound Corn . . 1 pound C.S.M. .	15–20		1	1	15–22		1	1
Silage at will* . . Alfalfa at will . .	10–15	4–6			10–18	5–8		
Alfalfa at will . . 2 pounds Corn .		7–10	2			9–12	2	
12 TO 18 MONTHS								
Silage at will . . 1 pound Corn . . 1 pound C.S.M. .	18–25		1	1	20–28		1	1
Silage at will . . Alfalfa at will . .	12–20	5–8			12–20	7–9		
Alfalfa at will . . 2 pounds Corn .		9–12	2			10–15	2	
18 TO 24 MONTHS								
Silage at will . . 1 pound Corn . . 1 pound C.S.M. .	22–30		1	1	25–35		1	1
Silage at will . . Alfalfa at will . .	15–25	7–9			15–30	8–10		
Alfalfa at will . . 2 pounds Corn .		10–14	2			14–18	2	

* Heifers less than 10 months old should receive additional grain.

The addition of timothy hay or oat straw will improve the first of these three rations, in which case there will be no reduction in the quantity of silage consumed.

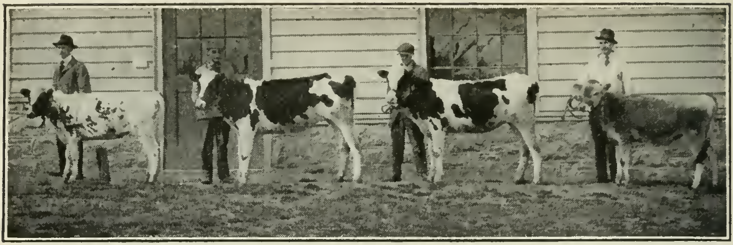


FIG. 62. Heifers wintered on corn silage and timothy

This group was given a poor ration to observe the effects upon gains the following summer. They averaged 13.8 pounds of silage, 3.3 pounds of timothy daily and had all they would consume. In addition a small amount of corn was fed one of the animals to prevent a loss in weight. The winter gain was 0.35 pounds compared to a normal of 0.82. They made practically a normal gain the following summer—0.88 pounds daily.

The Relation of the Winter Ration to Summer Gains. As previously stated, the growing period of a heifer extends over several seasons, and when pasture is available the winter feeding should be so managed that the best results may be secured in growth during the time the heifers are on grass.

Animals fed on a ration which results in a heavy gain during the winter make small gains the following summer on pasture. Those which make normal gains during the winter make about normal gains the following summer on pasture, while those which make gains below normal during the winter gain in excess of the normal during the summer. If winter conditions, however, are sufficiently extreme so that the animals are low in vitality in the spring, the gains made during the summer are not sufficient to make up for the small gains made during the winter.

Figure 63 illustrates the point mentioned, and presents graphically the results with three characteristic groups of animals. The general tendency here indicated was observed in all groups studied. The best results follow a winter ration of such a character that the animal makes a growth near normal. This means keeping them in moderate flesh.

The Breed Factor. Results show that usually the Holstein heifers thrive better than Jerseys on a ration of roughage alone.

In all comparisons of rations of this character the former used less energy per pound of gain.

Another interesting fact was observed during the summer of

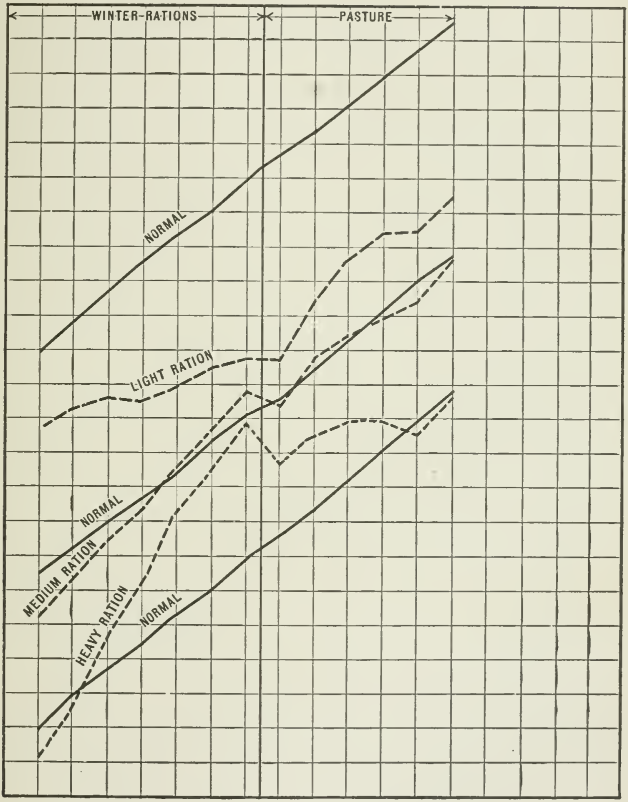


FIG. 63. Influence of winter gains on summer gains

Results are shown of animals wintered under three conditions: (1) the upper pair of lines represent a group (Fig. 62) that made gains far below normal in winter; (2) the middle pair represent a group that made normal winter gains; (3) the lower pair a group that received a high grain ration and made a gain far above normal during the winter. All were turned on pasture together. The first group made a good gain but did not reach normal by fall; the medium continued to grow at a normal rate on pasture; the overfat group made practically no gain in weight during the summer. The medium represents the proper plan of feeding.

1918. Heifers of three breeds from the wintering experiments were turned out together in early summer to a large blue grass pasture. On account of a long continued period of drought the grass became very short. Before the end of the pasturing season the Holstein heifers became so thin in flesh that it was necessary to feed hay regularly to the end of the season in order to maintain even a moderate state of flesh. The Jersey heifers remained in fair condition without any extra feed, while at the end of the season the Ayrshire heifers were in excellent condition—in fact, in more than moderate flesh on the grass alone.

Age at Which to Breed. The age at which the heifer should come into milk depends somewhat on the breed to which she belongs and the rapidity of development of the individual. In all herds there are some heifers which mature more slowly than others, and it is well to postpone breeding of backward animals two or three months. Lactation has an important influence on growth and development, and too early breeding is apt to result in undersize, and this in turn is reflected in the productive ability of the animal. This has previously been discussed in detail as one of the factors influencing growth.

Normally developed animals should be bred at the following ages:

Holsteins	19 to 21 months
Ayrshires	18 to 20 months
Guernseys	17 to 19 months
Jerseys	15 to 17 months

These figures are based on a study of the production records of the cows in the herd of the University of Missouri and further information on Ayrshire cattle contained in Maryland Station Bulletin 217. The production throughout a series of lactation periods is considered in both studies.

Care of the Heifer before Calving. Cows and heifers should always be in good physical condition at the time of parturition, in order to successfully pass through the ordeal of calving and meet the severe demands of a long period of lactation. In the case of heifers, good condition is of additional importance, as the animal should continue to grow while she is milking. The increased vitality due to judicious feeding before the calf is dropped will give her a reserve to draw on during the period of heavy milk flow.

The bulk of the ration fed may be any of the combinations suggested previously, but if no silage is at hand, roots or beet pulp would be excellent additions to furnish succulence which is very desirable in the ration just before calving time.

It is well to begin feeding heifers grain about three months before calving. The quantity will depend somewhat upon the character of the roughage. Two pounds a day is enough at first, and this should be increased gradually until 5 or 6 pounds are consumed. The purpose is not to have the animals overly fat, as is the case with cows for 7-day tests, but the grain feeding should be liberal enough to have them in good flesh at calving time.

A good ration can be made from ground corn, ground oats, bran, and linseed meal, using equal parts of each; or better, two parts bran to one of each of the others. Add about 4 pounds of salt to 500 pounds of the mixture. About two weeks before calving the grain mixture should be gradually changed by dropping out the corn and oats; so that the last ten days only bran and linseed meal will be fed. Careful watch must be kept on the condition of the bowels as calving time approaches, and a half pound of salts administered if there is any tendency toward constipation.

At the same time that grain feeding begins, it is well to bring the heifers into the barn with the herd at milking time if there is stall room. They can be fed while tied in the stanchions, which serves the double purpose of getting them accustomed to being tied in the barn, and also enables the feeder to keep close watch on their condition. They should be groomed with the rest of the cows, as this daily handling will overcome shyness and the heifers will be less nervous when milking begins.

A week or ten days before the calf is due to arrive, put the heifer in a well bedded box stall so that she will have time to get accustomed to her surroundings. Feed her regularly and see that she has salt and plenty of fresh drinking water, and if possible, a chance to exercise outdoors where she will not be molested or worried by other cows. Quiet surroundings are always desirable, especially with young animals undergoing the strain of calving for the first time.

Barns for Young Stock. In latitudes where winters are not too extreme a very convenient and comfortable shelter can be built for young stock at moderate expense. A long shed built of planed boards with battened joints set on a concrete foundation, and having a tight roof of shingles or prepared roofing, will serve very well. Windows with sliding sashes are needed for light and ventilation. The interior can be finished roughly into small stalls with hay racks and mangers. However, at slight additional cost wooden or metal stanchions may be built in and a concrete gutter, faced with 12 or 18 inches of concrete on both sides, will keep the bedding dry and the animals cleaner. The arrangement facilitates feeding operations and conserves bedding. It also affords good training for heifers. A shed of this kind 50 by 18 feet will accommodate 12 to 14 animals one to two years old, and allow space for a feeding alley and some feed storage. It should be built east and west, preferably with windows along the north and south walls. Those on the south side may remain open except in severe or stormy weather, and in very cold weather it is well to nail coarse cloth over some of the openings rather than close all windows tight, in order to prevent condensation of moisture.

Another satisfactory and cheap shelter is the partly open shed, closed on three sides but open to the south. The wall on this side can be carried to a height of 3 feet and the roof projected somewhat to exclude rain and snow. This arrangement necessitates the use of more bedding. A hay rack and manger at the back, or a row of stanchions, provide ample means of feeding. The animals run loose except when being fed. When ample bedding is provided the animals will be comfortable in this type of shed during the winter seasons ordinarily experienced throughout the corn belt.

Severity of climate should govern the type of barn used in all cases. In common with other farm animals dairy heifers should be protected from cold winds and storms, but when this is done, undue expense to provide warm quarters is seldom justified.

CHAPTER XX

PURE-BRED HERDS—THE BUSINESS SIDE OF THE PURE-BRED BUSINESS

What is a Pure Bred? The terms pedigreed stock, pure bred, or registered stock are used interchangeably. The term thoroughbred, formerly in common use—although incorrectly in this connection—has largely given way in recent years to the term pure bred. A pure bred is an animal descended in all lines of its ancestry from animals imported from the locality in which the breed to which the animal belongs originated. Evidence of such descent must be available in the form of registration records of these ancestors.

Registration. Breeders of improved cattle probably kept private records of their breeding operations long before registrations were established for the purpose of preserving these records. The first registration of animals in the modern sense began in 1822 when the first volume of the English Shorthorn Herd Book was published.

At the present time those interested in the various breeds have organizations to keep the records of ancestry in a systematic way and to make these records accessible to the public. The books containing these records are generally spoken of as herd books. When pure bred animals are imported, records of their ancestry and of their registration in the herd ·book of their native country are presented by the importers to the registry association of the breed in the United States. If the records are correct and the identification of the animal established, the registration is made in the books of the American association.

An animal born in this country is eligible to registration only when both sire and dam are registered. In making application for registration, the owner is required to certify to the name and registry number of sire and dam, the date of birth of the animal to be registered, the date of breeding of dam, and the owner of sire and dam. A sketch showing the color markings for identification is required of those breeds such as the Holstein or Guernsey, which are not solid colored.

The expenses of the registry association are met by charging a fee for registration and another for a transfer certificate issued to the buyer when an animal is sold. The fee is greatly increased if registration is delayed until the animal is past a year of age, and with most breeds is more for males than for females. It should be understood that the registration certificate is merely a record of ancestry. It does not in any way certify to the quality of the animal as a representative of the breed to which it belongs.

Advanced Registration and Official Testing. The present system of official testing which is the basis of Advanced Registration has grown from a small beginning to one of the most important factors in the breeding and development of pure-bred dairy cattle.

With the importation of many highly developed pure-bred dairy cattle in the decade following 1875, a wide public interest was aroused in the exceptional milk and butter production of many of these animals. Certain of the leaders among those interested in these newly established breeds, recognizing the importance of giving proper publicity to these records, were not satisfied with the practice of registering animals upon the basis of ancestry alone, and conceived the idea of a second or Advanced Registry to which only those animals would be eligible that showed a high order of merit.

The American Jersey Cattle Club apparently was the first Association to publish records of butter production, although the Holstein breeders were not far behind. The Jersey Cattle Club in 1884 inaugurated a plan of publishing butter records covering, as a rule, a period of seven days. The first volume of these tests was published in 1889. These tests were made by the owner according to his own practices and were reported under oath as to their accuracy. Cows making 14 pounds of butter or more in a week were spoken of as tested cows and said to be in the "14-pound list." No special system of requirements as to production and supervision of tests was made by this breed until 1903, when the present Register of Merit was established. Through the activities of Solomon Hoxie at the time of the consolidation of the Holstein and the Dutch-Friesian Associations in 1885, a provision was made for the establishment of an Advanced Register for that breed. This was the first of its kind. The animals were tested for milk and butter production under the supervision of the owner. Before being admitted to the Advanced Register it was necessary that the animal be inspected by a representative of the Association. If the production of milk and fat met the requirements and the animal came up to a certain standard by the score card, she was admitted to the Advanced Register and given a number.

The next important step in the development of testing for Advanced Registration was that of calling in a disinterested person to authenticate the record. Since agricultural colleges and experiment stations were coming into prominence, officers of these institutions were generally the ones called upon for this service. The Holstein Association in 1894 offered prizes for the best production by different ages, and definitely adopted the policy of having all tests competing for these prizes authenticated by the experiment station. This came to be known as official testing. This plan of asking the experiment station to take the responsibility for the accuracy of the tests has been since adopted by all dairy breeds.

Essentially the same plan is followed by the different breed associations, although the minimum requirements for entry vary somewhat and various names are given to the plan of registration as shown by the following:

Breed	Date Organized	Title
Holstein	1885	Advanced Register
Guernsey	1901	Advanced Register
Jersey	1902	Register of Merit
Ayrshire	1902	Advanced Register
Brown Swiss	1911	Register of Production
Shorthorn	——	Record of Merit
Red Polled	1908	Advanced Register
Dutch Belted	1912	Advanced Register

The classification of animals and the requirements for admission are fixed by each breed association as it sees fit. Prizes and medals are awarded in some cases to stimulate interest. The responsibility for the accuracy of the results reported for the period covered by the test is assumed by the agricultural college or experiment station having charge of this work in the state in which is located the animal to be tested. In those states where a considerable amount of testing of this kind is called for, an official known as the Superintendent of Official Testing is generally appointed. The superintendent has the appointment and supervision of the men who do the testing and who are known as supervisors. He also has the right to prepare such rules as he sees fit to govern the conduct of the test, although standard rules have been formulated by the American Dairy Science Association and are in use in most of the states.

When a breeder desires to test a certain cow, he makes such arrangements with his breed officials as is required by the rule of the association. The breed association then requests the Superintendent of Official Testing in the state where the herd is located to conduct the test for the specified length of time. A test supervisor is sent who watches each cow milked, personally weighs the milk, and makes a test for butter fat, using the Babcock method. The results are reported on suitable blanks, under oath, and serve as the basis for Advanced Registration of the animal tested. The supervisor in doing the testing is a representative of the college or experiment station having the work in charge. He is subject only to their orders and receives his compensation from them.

The growth of official testing has been very rapid. The states in which the largest amount is done are New York, Wisconsin, Ohio, Pennsylvania, and Minnesota. One of these states has had as many as 130 supervisors at work at the time of the maximum demand for the year. Official testing is for the breeder of pure-bred cattle, not for the dairy farmer who is interested in milk production alone. For him the cow-test association serves the purpose to better advantage.

In doing official testing the purpose is not primarily that of finding out which cows are profitable producers as is the case with the cow test association. The owner generally knows himself about what his animals are producing before beginning official testing. His purpose is to obtain records of production that will be unquestioned by the public, on account of having been authenticated by an institution in which the public has confidence. The purpose of the breeder in having such records is primarily to increase the market value of his stock, both for the future and for the present. Official testing has come to serve as the basis upon which most of the breeding animals of dairy breeds are selected. It is also the chief factor in determining the value of registered dairy animals. With the high price level of recent years, a single test covering a period of only seven days has often added thousands of dollars to the value of an animal.

Objection to Short Time Tests. When advanced registry testing was begun about 1890, the test period was usually seven days. The results were at first fairly satisfactory, since under what may perhaps be called normal conditions the production of a cow for even seven days seems a fair index of her milking abilities. It is admitted, however, that in some cases the cow that is capable of making a large 7-day record under normal conditions lacks persistency in milking and her yield for the year may be considerably less than that of another, the 7-day record of which is far less. Even with this chance for misjudging an animal it is not probable that any serious objection would have arisen to the short time test were it not for certain developments which greatly changed the situation.

The basis of the serious criticism of the short-time test record, in recent years amounting to a complete condemnation of it on the part of many dairy authorities, is the opportunity it affords to obtain an abnormal and therefore deceptive fat percentage in the milk.

In 1910 the author[1] published experimental data showing the abnormal fat percentage possible in a short-time test and the conditions under which it is obtained. It was demonstrated that the important factor in obtaining the high fat content during the short-time test is that of putting the cow in an excessively fat condition before freshening, then feeding her in such a manner that a considerable amount of fat is taken from fat stored on the body. A temporary increase in the richness of milk may be brought about at any stage of lactation provided the cow is in good flesh and that her ration is suddenly lowered to a point where she begins to draw freely upon her body for nutrients to support the milk production. The fresh cow, especially when in high condition, is usually underfed for a time without any intention on the part of the feeder, since a heavy producing cow can not eat sufficiently at that time to supply the nutrients needed for the milk she is producing.

The extent to which official records of milk and fat production gradually came to determine the value of dairy animals resulted naturally in every possible effort being made to secure the maximum production during the period of test. The information as to the possibility of securing a high fat test during a short-test period soon became common knowledge. As a result, conditions under which short-time tests are made—such as the fitting of cows for months in advance by high feeding and having them dry for long periods—have become so extreme that the fat content shown by a short-time test has little if any significance as to the normal richness of the milk produced by the cow during the entire lactation period.

---

[1] Hoard's Dairyman, 1910.

In the original experimental work conducted by the author a 7-day record of a cow especially fitted was made under rules of the Holstein-Friesian Association, showing a fat percentage of 5.1. The milk of this cow was tested throughout her milking period, with an average fat percentage of 3.40. The next year she was not fattened before calving but was in what would generally be called a normal condition. For seven days beginning the same length of time after calving as was the case in the test the previous year when especially fitted, her milk averaged 3.63 per cent fat. During this second lactation period she averaged 3.34 per cent of fat, practically the same as during the first year.

An abundance of evidence concerning these questions may be obtained from the official records of the breed associations. For example in a recent volume of the Advanced Registry of the Holstein-Friesian Association 30 cows are listed as having records of 40 pounds of butter (80% fat) in seven days. Of these only five were tested for a year but a comparison of the records of these is typical of what would be found if records were available for the others.

TABLE 50. RECORDS OF FIVE COWS HAVING OVER 40 POUNDS BUTTER IN 7 DAYS AND ALSO A RECORD FOR A YEAR

	LBS. MILK FOR YEAR	LBS. FAT FOR YEAR	PER CENT FAT FOR YEAR	PER CENT FAT FOR 7-DAY TEST
	13,964	560	4.09	5.60
	29,825	952	3.12	4.50
	18,819	574	3.05	6.02
	27,009	836	3.05	4.43
	17,935	685	3.81	6.06
Aver.	21,510	721	3.43	5.32

It will be noted that these five cows average 5.32 per cent of fat for seven days and 3.43—typical of the breed—for a year.

These figures show that short-time tests do not furnish a fair basis upon which to base breeding operations so far as the fat percentage is concerned. The milk yield is much more significant, and it, rather than the fat, should be given attention in connection with short-time records.

Number of Pure-bred Cattle. Before establishing a business enterprise of any kind a study of the available supply and the probable demand for the product would be wise. If this is done for the pure-bred dairy cattle business the conclusion must be that the opportunities are unlimited.

The census figures for 1920 show 23,724,148 dairy cows and a total of 32,534,797 animals of the dairy breeds in the United States. Of these 772,320 were bulls over one year of age, or one to each 31 cows in milk, of which 28 per cent were pure-bred. There were 556,071 grade or scrub bulls in use, all of which should be replaced by pure-breds. In certain states 40 to 60 per cent of the bulls are pure-bred. This shows it is possible, with a proper appreciation of good blood by the public, to double the number of pure-bred bulls now in use.

Table 51 gives the number of pure-bred dairy cattle by breeds as enumerated in the census of 1920, and the total number, including grades of the various breeds as estimated by the U. S. Bureau of Markets and Crop Estimates.

TABLE 51. PURE-BREDS AND GRADES OF THE DAIRY BREEDS IN THE UNITED STATES

BREED	TOTAL PURE-BRED 1920	TOTAL INCLUDING GRADES
Holstein	528,446	11,069,000
Jersey	231,824	9,554,000
Guernsey	79,445	1,993,000
Ayrshire	30,456	412,000
Brown Swiss	8,283	170,000
All others	37,909	

Pure-breds vs. Grades. The great bulk of dairy products on the market comes at present, and should come in the future, from herds which are high grade but not registered. The typical herd for the nine out of ten farmers producing milk for market is one of well selected, high-grade cows headed by a pure-bred bull. Many farmers who buy a registered cow for the first time are disappointed that she is not far superior to their grades. If the grade herd has been bred up by the use of pure-bred bulls for several generations, and the inferior producers eliminated, there is no reason to expect that a pure-bred will excel the grades.

Registration papers do not insure any greater or more economical production than is possible by selected high grades of the same breed. It is true, however, that registered cows produce on the average more milk than grades of the same breed, partly on account of their purity of blood, but also on account of the fact that they are usually in the hands of men who give more careful attention to individual selection and to proper care and management.

The difference in the production of grades and pure-breds under conditions as they exist on dairy farms is shown by results reported by the Extension Service of the Pennsylvania State College from a compilation of records from cow-test associations in that state.

	Number of Animals	Average Lbs. Fat Production for Year
HOLSTEINS		
Pure-breds, all ages	306	299
Grades, all ages	707	260
JERSEYS		
Pure-breds, all ages	101	308
Grades, all ages	306	275

The Holstein pure-breds surpassed the grades 39 pounds in fat production and the Jersey pure-breds showed a lead of 33 pounds of fat.

Pure-breds are the seed stock for the grade herds that will continue to supply the bulk of the milk products. The pure-bred breeders have taken over this great responsibility of maintaining and improving the breed. In these herds all breed improvement is made, and by the distribution of seed stock, largely in the form of pure-bred bulls, this improvement is gradually spread to the great mass of grade animals representing the sub-strata of the breed.

There are two fairly distinct classes of breeders, with other classes ranging between. The first class is the well established breeder with a high-class herd, and includes the great breeders and the real improvers of the breed. Such herds supply the bulls and the foundation females for the second class. Their stock is mostly too high in price to supply the dairy farmer desiring a bull to head a grade herd. Other breeders of pure-breds supply the market for this class of stock. The second class is composed of those breeders not so well established in the business, or those having herds less valuable in breeding and individual excellence. In this class the breeders are the distributors of pure-bred bulls to the dairy farmer. The beginner must expect to find himself in this class in the early stages of the development of his herd. The ability of the breeder will determine whether he stays in this class or advances to the point where he is considered a constructive breeder, and animals of his breeding are in demand by other breeders of pure-breds.

Possibilities of a Pure-Bred Herd. To a person born with a love for animals, business ability of a high order, and the patience to await results, the pure-bred business offers exceptional opportunities. Many examples could be cited. The author at one time purchased four foundation cows for the institution with which he was connected at the low price of $600. No other females were purchased. At the end of fifteen years it was found that surplus animals had been sold to the amount of $13,800, and that 44 females were on hand, which had an inventory value of $17,000. The value of the milk sold was not included in these figures, but it was sufficient to pay expenses under practical conditions making the pure-bred herd a splendid investment. A Guernsey breeder reports a herd of 21 pure-bred animals on hand, all descended in 10 years from one cow. Forty-one pure-bred calves were dropped on the farm during the 10-year period.

Investigation will show that nearly all successful breeders started in a small way and gradually grew into the business, developing their herd and extending their prestige as a breeder from year to year. The pure-bred business is of slow growth and cannot be forced. The young man going into business should not count too much at first on the sales of pure-bred animals. He should make his plans with the idea of paying the operating expenses from the sale of dairy products, and not from the sale of breeding stock. It requires at least 10 years for a pure-bred breeder to become established and for his herd to become known to the extent that his stock is in demand at good prices. During this period the breeder must manage his herd with skill and judgment, cull out the inferior animals without regard to pedigree and under no conditions be persuaded to sell his best, and he must give the most careful attention to all details of his business.

Reputation an Asset. The reputation of the breeder is no small part of his capital stock and should be most carefully guarded and built up by square dealing and liberal treatment of the buyers. A reputation once built up is an asset that remains during the entire lifetime of the breeders and beyond. The very foundation of the business of breeding pedigreed animals depends upon the honor and integrity of the men engaged in it. Probably 90 per cent of the pure-bred males in use are purchased by correspondence and the transaction is based upon the reliability of the breeder.

In selling pure-bred livestock it is good business policy to make every effort to have all customers satisfied, even though it may mean considerable expense and being asked at times by purchasers to make adjustments which are unreasonable. The more successful breeders to a large extent adopt the policy of some of the successful retail stores that "the customer is always right."

Breeders' Business Code. A breeders' association recently adopted a set of rules to govern the relations between buyer and seller of pure-bred cattle which are worthy of wide adoption. They are as follows:

> All prices quoted are on the basis of free delivery of the animal to the seller's shipping station.
>
> Animals to be shipped by express are crated free by the seller and the crate returned at the expense of the seller.
>
> All animals shipped are to be provided with a strong halter.
>
> Every bull over one year old is guaranteed a breeder provided the buyer's cows are in good condition. If not a breeder the animal shall be replaced by one equally as good or to be returned to the seller and purchase price refunded at the option of the seller. In case of exchange buyer and seller each are to pay transportation charges one way. If the animal is taken back the seller pays transportation charges.
>
> Every cow or heifer over one year old when sold is guaranteed a breeder and taken back or exchanged on the same basis as for bulls.
>
> The seller must call attention to any unsoundness of udder or otherwise, but, if an animal sold as a heifer proves to have a defective udder when she calves, it is the purchaser's loss.
>
> Registry certificate, transfer papers, and tabulated pedigree are to accompany every sale.
>
> In states where provision is made for accredited tuberculosis-free herds it is recommended that all breeders have their herds enrolled. When a buyer tests an animal inside of three months after purchasing and finds the animal tubercular and no other reactors in his herd the loss falls on the seller, unless he is able to show a test made within ninety days before the sale and that no reactors were in the herd at this time.

Delay on the part of the seller in supplying the purchaser with the registration and transfer papers is the cause of much friction and is inexcusable.

It is a wise precaution for the purchaser to withhold part of the purchase price until registration and transfer papers are secured.

Advertising the Herd. A mistake made by most beginners in the breeding business is to expect to find a sufficient market for their surplus animals among their neighbors. Experience soon teaches that a wider market than the immediate neighborhood must be found. It is human nature to think that conditions at a distance are better than at home, and there is a tendency to go away from home to purchase, even if equally good animals are available close at hand. No livestock breeder ever made much of a success selling breeding stock to his neighbors alone. He must in some way get a reputation wide enough to bring buyers from a distance.

The breeder of dairy cattle has three ways of bringing his stock to the attention of the public: (1) advertising in good agricultural papers, (2) exhibiting at fairs, and (3) making official milk and butter records so good that they will attract attention. Unquestionably, skillful advertising in good agricultural papers is the most effective means of getting before the buying public. Persistent advertising seems to bring the best results. A reader confronted weekly with the name of a certain farm or breeder after awhile has that name so firmly fixed in his mind that he naturally goes to this place to supply his wants.

The breeder who wishes to advertise should select the papers that circulate among the people to whom he can reasonably expect to sell his stock. A breeder who has animals that should be placed at the head of pure-bred herds and command the highest range of prices for the breed should usually select the special breed papers. Those who have animals that will sell largely to owners of grade herds find the dairy journals or the general agricultural papers the best medium. Exhibiting at fairs, with the publicity that goes with it, is an effective means of advertising. However, there are some serious objections. One is the danger in shipping and exhibiting high-producing cows in the stage of lactation necessary to make the best impression in the show ring. Another, and at times more serious, danger is that of contracting disease—especially tuberculosis. More stringent rules are being adopted from year to year, and in the near future danger from this source may be mostly eliminated. In the past many times a herd came back from the fair bringing with it an infection of tuberculosis which could only be eliminated by years of effort.

For most breeders the best means of getting before the public is by means of official testing. This is especially true of the small breeder and beginner. The man who has a herd so small that he can look after it himself has an opportunity along this line, except in regard to numbers of animals to choose from, equal if not superior to that possessed by the large breeder who depends upon employees altogether. Good records become news material and are gladly printed by local papers and even by agricultural papers having a wide circulation. This is the best possible advertising.

Naturally a breeder must have the stock to show when buyers come. When animals are shipped it is very important that they be in splendid condition. When a man receives a high-priced bull calf his neighbors all come to have a look and the animal should be one he can show with pride. Farmers often say they do not want the breeding stock they buy fat; but fat covers a multitude of defects, even with dairy animals, and the calf a little fatter than is really necessary is the one that best pleases most buyers.

Acquiring a Knowledge of Pedigrees. If one is to become a successful breeder of pure-bred cattle it is necessary to become familiar with the prominent animals and best known lines of breeding within the breed used. To gain this information and to keep up to date requires constant study. A breeder who is engaged in the business on a considerable scale will do well to purchase a set of herd books and become a member of his breed association in order to secure the volumes as they are issued.

Anyone familiar with the method can make up a tabulated pedigree from the herd books. However, the official records are an important part of the pedigree and these are obtained from another volume or series of volumes depending upon the association concerned. Even when the breeder does not feel justified in purchasing a set of herd books it will be advisable to have a copy of the most recent volume giving reports of official records at hand. Sale catalogues should be preserved and studied. Attendance at a few high-class public sales, with a careful study of the pedigrees of the animal sold with reference to the selling price, is also an excellent means of becoming familiar with the popular lines of breeding. The breeder should also be a close reader of the special publication or journal published in the interest of his breed.

Public sales and cattle shows also afford opportunities to meet fellow breeders and to widen the scope of one's information regarding his own breed.

Naming Pure-bred Cattle. The rules for the registration of pure-bred animals require that no name can be accepted that has already been used in the herd book. This requirement causes some difficulty in selecting a suitable name, when in some associations over half a million have been registered. This annoyance may be avoided, and at the same time advertising possibilities realized by having a suitable plan of naming.

The best plan for naming involves the use of either a certain prefix or a suffix to the name of all animals registered from the herd. The common practice is to select a suitable name for the herd or farm and use this as the prefix or suffix. An example is the word "Pontiac" used as a prefix by a well-known Holstein herd and the phrase "of Hood Farm" used as a suffix by a Jersey breeder.

The plan adopted by the author involves the use of a prefix indicating the herd, the second name indicates the sire, and the third indicates the individual and generally suggests some of the ancestors of the animal. In this particular case the herd prefix is "Minnehaha." Offspring of Majesty's Origa, for example, are named Minnehaha Majesty ——— with a third name to designate the individual. The breed organizations recognize the value of such a prefix or suffix and give a breeder the exclusive right to use it in naming registered animals. In time the public comes to associate the particular name with the herd, and each time the name of an animal appears in print the herd from which it came is fixed more firmly in the minds of the reader.

Such a system may not appeal to a breeder accustomed to speaking of his cows by name unless the third name is one that may be used. A satisfactory plan to use in connection with such a naming system is to give each animal a herd number at birth which is never changed and to keep all records by this herd number. The animal can be referred to by number as well as by name among the attendants.

Suggestions to Breeders. The breeder will be most successful who insists upon individual merit as well as good pedigrees. The breeder building up a herd is often reluctant to discard animals of inferior individuality from his herd when they are well bred and possibly the offspring of some of his best breeding stock. A pedigree, no matter how popular, should never be made the excuse for keeping animals in the herd that are not creditable representatives of the breed. Inferior animals will appear in any herd but the breeder of judgment does not retain them for breeding purposes, neither does he sell them to others for breeding animals; but he sends them to market, or, if too valuable for slaughter, disposes of them as grades without giving registration papers.

Fads frequently develop for certain colors or combinations of breeding which have no real foundation of value. The breeder should avoid the danger of injuring his herd by attempting to follow these temporary fads, although some attention must be given to meeting the popular demands. For example, a black nose is considered undesirable in pure-bred Guernseys. While this is something of a fad in so far as it has no real significance from the standpoint of the milk producing ability of the cows, a breeder would be wise to avoid breeding animals with this characteristic, for it will interfere with the sale of his stock.

The breeder should become a good judge of the breed of cattle in which he is interested, and attendance at fairs where the judging is under way is of material assistance. Visits to leading herds, with a careful study of the breeding animals in use, are also worth while.

It should be kept clearly in mind that feeding is of equal importance with breeding. No herd of cattle, no matter how well bred, will make a creditable showing either in appearance or in production without liberal and intelligent feeding. Many of the failures in the breeding of pure-bred cattle are clearly due to improper feeding—often combined with the keeping of inferior animals in the herd on account of their pedigree.

A suitable system of marking the animals is of great importance, not only on account of the danger of mistaking one young animal for another, but a practice of depending upon the memory of the owner does not tend to inspire confidence in prospective buyers.

A system of keeping the herd records is also necessary. A form for this purpose has been described in a previous chapter. In addition to the book for keeping milk and butter records a barn book is needed in which information concerning breeding and the birth of calves may be recorded. Satisfactory books for these purposes can be prepared by suitable ruling in a blank book, or well designed books may be had from the publishers of dairy journals.

The pure-bred breeder must also recognize the importance of keeping his premises in an attractive condition. The sale of meat animals taking place in a general market away from the farm does not in any way depend upon the condition of the premises where they were grown, except in so far as the presence of disease might be a consideration. With the seller of pure-bred cattle the conditions are quite different. His premises must be neat, well kept, and free from disease. A set of buildings showing a run-down appearance and a general lack of thrift will do more to destroy confidence in the seller than the most active salesman can counteract.

Selling by Mail. A large share of the business of selling pure-bred livestock, especially by those who sell the less expensive grades including bulls for grade herds, is done by mail. To sell goods successfully by mail taxes the ingenuity and resourcefulness of the best trained business man. The beginner in the pure-bred business has much to learn and he must make a study of the proper methods of handling these details satisfactorily or he cannot long remain in business. The amount of correspondence required to make a sale surprises the inexperienced man. If one sale is made to each five inquiries, the seller should consider he is doing as well as the average. A breeder should provide some office equipment in the form of a suitable desk, a typewriter, filing cases, and well printed letter heads. Every inquiry should be answered promptly, although no animals of the description called for are for sale. This is important as a means of holding the good will of possible buyers in the future. Carbon copies of all letters should be kept to avoid disputes over prices quoted and descriptions of animals. The breeder, or someone in his family, should learn to use the typewriter sufficiently to type all letters.

When the animal to be sold is of a class to justify the expense, a printed tabulated pedigree may be ordered in sufficient quantity to meet the probable needs at a moderate expense. A copy of the printed pedigree which will give all official records in the pedigree is sent to each prospective buyer together with a written description of the animal. When the breeder does not feel justified in having a pedigree printed for each animal offered for sale, he may wish to have printed pedigrees available of his herd sire. In answering an inquiry with these available it is possible to send a copy of the sire's pedigree, leaving only the breeding on the dam's side to be given especially. Care should be taken to avoid all long, involved statements of ancestry. Some prefer to make out a fully tabulated pedigree written either by hand or with a typewriter. The objection to this is that often many inquiries are answered before a sale is made requiring a large expense in time in preparing the pedigree.

A plan followed by the author for a number of years with satisfaction is to prepare a statement concerning each bull to be sold shortly after it is born. This description is typewritten on thin paper, enabling several copies to be made at once. In answering an inquiry a printed pedigree of the herd sire is sent together with the descriptions of such animals as seemed to best meet the needs of the buyer. The following is the form of description used:

HOLSTEIN BULL, HERD NO. 320

Name: Minnehaha Homestead Ormsby.

Born: January 2, 1922.

Description: About two-thirds white, large and vigorous for his age, level rump and good barrel.

Sire: See enclosed pedigree.

Dam: Facile Aaggie of Shady Nook. With an official record of 23,372 pounds of milk and 781 pounds of fat in one year. She was first prize aged cow at the Minnesota State Fair in 1918. Her daughter, a full sister of the bull offered, has a record of 20,001 pounds of milk and 697 pounds of fat as a two-year-old.

Tuberculin Test: The herd is on both State and Federal accredited lists.

Price: $350 includes registration and transfer papers and tabulated pedigree, f. o. b. St. Paul. Photograph and fully tabulated pedigree will be supplied upon request.

For nine out of ten buyers a description of this kind is all that is desired. A tabulated pedigree is prepared and a copy sent only on special request. When the animal is sold the tabulated pedigree is forwarded with the registration and transfer papers.

The Public Sale. There are two classes of public sales, individual and consignment. A public sale has many advantages and some disadvantages as well. Only a large breeding establishment can furnish sufficient animals to justify a public sale except in case the herd is dispersed. There is always considerable expense in conducting a public sale. To make a successful sale the breeder must be well known and have a reputation for desirable stock that will lead buyers to come some distance to buy. Unfavorable weather may nearly ruin a sale. Often the prices realized at public sales are better than could be obtained at a private sale. This is especially true when the demand is brisk and conditions such that the general trend of prices is upward. At such a time the enthusiasm of the buyers often results in prices much above the going price at private sale. When conditions in the business are unfavorable and confidence is lacking among prospective buyers, the reverse is true and the prices at public auction are usually lower than could be received at private sale. For the individual, the public sale has the advantage of concentrating into a short period all the labor of preparing animals for sale, getting the necessary information ready, and attending to the numerous details the sale of breeding animals requires.

The consignment sale may be held by a group of breeders and may be of local character or a state or national organization may assume the responsibility, giving the sale a state or national scope. In recent years the conditions under which such sales are conducted are usually controlled in a satisfactory manner, insuring fair treatment to the buyer. Care is taken that the animals consigned are sound and of good quality. By-bidding is forbidden, and a genuine effort is made to conduct the sale in a manner which shall be above criticism. The expenses of conducting a public sale are considerable. Consigners to public sales usually pay 10 per cent of the selling price for the expenses of the sale. This covers advertising, the auctioneer's fee, providing of the facilities for the sale, and all minor expenses. The consignor pays all expenses of preparing his stock, shipping to place of sale, and caring for them until they are sold and delivered.

CHAPTER XXI

CARE AND MANAGEMENT

Importance of Proper Management. It is pointed out elsewhere that the results obtained from a dairy cow depend first of all upon her inherited capacity to produce milk—that is, the efficiency of the machine—and, second, upon how skillfully the machine is used. Skill in using the machine includes, first of all, intelligent feeding, but in addition the care and attention with which the numerous other details of management are carried out has a large share in the final results obtained. The astonishing milk and fat records made in recent years are due, not to any sudden increase in the capacity of cows to produce milk, but mostly to better methods of breeding and handling.

Regularity and Gentleness in Handling. The dairy cow is a creature of habit. She easily becomes accustomed to a regular routine regarding feed and care, and any change from this program tends to disturb her and to cause a decrease in milk production. Experience shows that regularity in all details is one of the essential factors in keeping the milk flow constant. Either the grain or the roughage may be fed first, but the same order of feeding should be followed regularly. A cow may be readily accustomed to eating grain before milking, at the time of milking, or following, but she will be uneasy if the same routine is not followed all the time. It is especially important that the milking be done at the same hour and under the same conditions so far as possible.

The highly developed dairy cow is inclined to be of a nervous disposition and is easily excited. Furthermore, it is necessary for the attendants to come into close contact with her in feeding, milking, and other work in the barn, and consequently, it is exceedingly important that the best of relations exist between the cow and her keeper, in order to get the largest amount of milk and do the work as quickly as possible. In order to establish the right relationship, the cow must not be afraid of the man. The cow is not adapted for rapid locomotion and should never be hurried from a moderate walk. Chasing cows with dogs or driving them on the run with horses is not allowed on any well managed dairy farm. In the barn the men must work quietly. Loud shouting and quick movements among the animals excite them and often result in cows' forming a habit of holding up the milk or of kicking.

Exercise and Grooming. When the question is raised of how much exercise a dairy cow should have, the thought is, How much time should she be turned loose out of doors and to what extent should she be required to walk? The fact is often overlooked that all the organs of the body are performing heavy labor during lactation. A cow producing 25 pounds of milk daily must chew and digest roughage containing from 15 to 18 pounds of dry matter and grain containing from 6 to 8 pounds. The process of changing this into blood and then into milk is a severe tax upon all organs of the body. The cow, except in so far as the muscles used in walking are concerned, is doing more work than is a horse working all day in the field. These facts explain why cows in milk can thrive for long periods with little exercise so far as walking about is concerned. In fact, the cow does not need any large amount of exercise to keep in good condition since her job is not walking but producing milk, and her organs are well exercised for this purpose.

It is well, however, to give the cow some exercise regularly, although heavy producers should not be required to walk long distances. During mild, fair days in winter, cows should be turned outside for a few hours, and in summer all ages should have the freedom of the pasture for a part or all of the time. Uncomfortable stalls or ties if used are an additional reason for giving the animals freedom at times.

Dairy cows when kept confined in the barn most of the time should be groomed daily. When on pasture less frequent attention is necessary although always desirable. The value of grooming is primarily that of keeping the skin of the animal clean, which is necessary for the production of clean milk. Grooming is also desirable for the health of the animal. Experimental trials made mostly with cows producing only a medium amount of milk have shown little, if any, increase in milk production. The conditions, however, are quite different with heavy-producing animals, especially when they are confined in the barn for long periods. Omitting the grooming of cows under these conditions would be a serious mistake both from the standpoint of clean milk production and from that of amount produced.

For general use in grooming cows a stiff brush is preferred, although an ordinary currycomb is needed when the animal becomes soiled with manure. During hot weather it is a common practice in some dairies where water pressure is available to wash the cows by using a hose. In Holland the cows are washed frequently by the aid of a brush.

The Period of Gestation. The average period of gestation for the cow is 280 days. Wing, in reporting a study made of 182 births, states that the shortest period was 264 days, the longest 296 days, and that approximately an equal number of births occurred on each day from the 274th to the 287th day. He found no difference in the gestation period of male and female calves.

Fall vs. Spring Calving. Under conditions of nature the cow probably gave birth to her young in the spring or early summer as do wild animals of related species at present. Under conditions of domestication, where feed is supplied in abundance the year around and all conditions of physical comfort of the animals provided for, the seasonal character of reproduction has been lost. The herdsman now regulates upon economic considerations the time of the year in which the calves are to be born.

Under rather primitive conditions of agriculture, and in the first stages of the development of specialized dairy farming as well, the custom is to have the calves born in the spring. The cows produce most of their milk during the pasturing season, are nearly dry by the beginning of winter, and are completely so by mid-winter. Under this condition the largest milk flow is produced from pasture, which is generally the cheapest feed if the labor of growing winter feed is taken into account. This practice, as a rule, goes with a small average milk production. It is justified under some conditions—for example, when summer feed is cheap but proper winter rations are expensive.

After dairy farming has passed through the early stages of development in a community, provisions begin to be made for better feed supplies, including succulent feeds such as silage or root crops, for periods when pasture is not available. Better accommodations in the way of barns become common and the cows are expected to continue to produce milk at least 10 months in the year. When these conditions are reached, the advantages of having the cows freshen in the fall begin to be recognized.

It is found where good conditions are maintained that cows calving in the fall will produce more milk during the year than those calving in the spring, and that the average fat content will be a little higher. Furthermore, the farmer, if engaged in general farming as well, has more time to give to the cows and to calf raising in winter. It is also of considerable advantage to have the dry period come during the heat of late summer when the weather conditions are unfavorable for milk production. Still another advantage is that fall calving brings the highest production at the time of highest market prices.

In studying this subject the author made a compilation of the records of 32 cows, each of which had a lactation period beginning in the fall (October to December) and another in the spring (April to June). The results are as follows:

COMPARISON OF SPRING AND FALL CALVING

	LBS. MILK IN YEAR	LBS. FAT IN YEAR	AVERAGE PER CENT FAT
Spring Calving . .	6,451	293	4.54
Fall Calving . . .	7,125	339	4.75

These figures show that the 32 cows averaged about 10 per cent more milk and 15 per cent more fat during the milking period beginning in the fall. Where for some reason it is desirable to have a uniform amount of product to market throughout the year the plan is followed of having the herd divided in the time of freshening between spring or fall. In other herds, especially pure-bred ones, no attempt is made to regulate the time of freshening to any particular month or season.

Dehorning. For the ordinary business herd there is every reason why the animals should be dehorned. Before domestication, horns were a useful protection against other wild animals, but horns on a dairy cow of today serve no useful purpose and are the source of much annoyance. They are responsible for frequent injuries—often serious, and especially to the udder. Dehorned cattle may be housed in a much smaller space; and when they are fed and watered together in the ordinary manner, there is a material saving in labor. Horns on a bull are extremely dangerous. The only case where it is advisable not to remove the horns is that of high-class animals which are likely to be used for show purposes. While the scale of points for the various breeds allow only one or two points for horns, a dehorned animal loses much more than that score card indicates when in the show ring. Dehorned animals are occasionally found in the show ring, but the leading show animals are practically all horned.

Use of caustic potash. The best method of dehorning is to use caustic potash on the young calf. To use this successfully, the dehorning must be done before the calf is three days old. The hair is clipped away from the small buttons, which may be felt and which are the future horns. A stick of caustic potash is then moistened a trifle and rubbed on the spot until the skin bleeds slightly. Care must be taken to avoid getting too much water on the animal, or it may run down the head, taking off the hair—and even getting into the eyes, with serious results. If sufficient caustic potash has been applied, a dent will be felt in the skull after a few days, and no horns will ever develop.

Use of saw or clippers. The most common method of dehorning is by the use of the saw or clippers. For animals from 6 to 12 months old the clippers are recommended, while for the older animals, especially after maturity, the saw is more desirable on account of the danger of crushing the horn if clippers are used.

The dehorning should be done during the cool weather of spring or autumn. If done in hot weather means must be taken to keep the flies out of the wound. When taking the horns off with instruments, care must be taken to cut sufficiently close to the head. The rule is to cut from a quarter to half an inch below where the skin joins the horns, leaving a rim of the skin on the horn removed.

A suitable means of securing the animal is necessary in following these methods. A strong stanchion is generally used and the animal's head further secured by a strong halter. Those inexperienced in this work will do well to observe some one else perform the operation before attempting it. Details concerning methods of tying animals and performing the work may be had from various bulletins on the subject.

Effect upon the animals. The pain resulting from the operation may be easily overestimated. Careful observation has shown that the dehorning of cows in milk does not materially affect their milk production, even during the first few days following the operation and not at all after a few days.

One experiment station reports a loss of 7 per cent for three milkings, another one pound per day for four days, and still another one-half pound a day for two days. It has also been observed that the disturbance due to dehorning a portion of the herd exerts as much effect upon cows in milk not dehorned as upon those upon whom the operation has been performed.

The worry, pain, and cruelty of the animals to their mates is eliminated with the horns, and a quiet contentment of the herd is at once noticeable.

Training the Horns. The breeder of pure-bred cattle, especially when in the habit of exhibiting in competition, not only desires that his animals retain their horns, but is interested that they be developed in such a way as to add to the beauty of the animal. The horns can be made to grow in almost any shape desired by the proper use of horn trainers. The horn trainer is a metal device so constructed that such pressure may be applied to the growing horn as seems necessary to give it the desired form.

The trainers should be applied when the horns are about two inches long but not before they have become set solidly to the head. The trainers should be tightened a little every day until the horns assume the shape desired. Sometimes when it is desired to have the horns curve in, holes are bored in the ends of the horns and a piece of wire used to gradually draw the tips inward. If the horns are turning up more than desired, sheet lead may be used to weight them. The file and sandpaper are used to smooth off rough spots and angles.

Marking Cattle. In breeding pure-bred cattle it is very essential that some practical system of marking the individuals be adopted. Even if a breeder feels that he can depend upon memory alone, it is not advisable to do so. The records of some valuable herds have been lost through the death of the owner, who was the only one who knew the individual animals.

The common practice of taking dairy-bred calves away from the dams soon after birth to be raised by hand makes it much more uncertain to depend upon memory to identify these animals than is the case with beef-bred cows, where the calf is raised by the mother in the natural way and the owner has several months' time in which to learn the individuals.

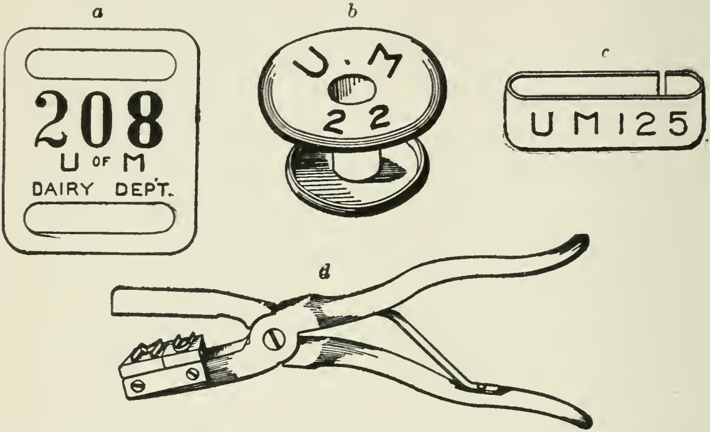


Fig. 64. Devices for marking cattle. *a*, brass tag to go on strap; *b*, *c*, ear tags; *d*, tattoo marker.

When a buyer visits a herd, a much better impression is made if every animal bears a tag. Every calf should be tagged in some manner within a few days after birth, and a record made in the herd book to identify the animal. It is important, even in grade herds, especially when they are large, to have a permanent mark of some kind that may be used as a means of identification if question of ownership should arise.

There are several methods in more or less general use for this purpose. A common plan is the use of ear tags of various forms, bearing numbers, and, if desired, the name and address of the owner. Some of the forms in use are shown in Fig. 64. The chief objection to these is that they are frequently torn from the ear by being caught in a fence or branch of a tree, and in this way not only is the mark lost, but the animal disfigured as well. An advantage of this type is that it may be removed and another substituted if desired. In inserting these tags care should be taken not to close them too tightly on the ear, as a soreness may result which leads the animal to rub the ear and tear out the tag.

Various systems of notching the ear to indicate numbers are also in use. These are satisfactory, except that the animal is disfigured, and the system must be known in order to read the number. Another method in use is to burn the number on the horn or hoof. A mark on the hoof must be renewed at intervals, and one on the horn is occasionally lost by the horn being broken off; it is impracticable also in many herds, on account of the practice of dehorning. The young calf cannot be marked in this manner. Some breeders mark the animals by placing a brass tag bearing a number on a strap about the neck. This is especially well adapted for calves.

For use with all breeds having light-colored skin in the ears the tattoo mark is the most satisfactory of all. This consists in printing the numbers or letters as desired in the skin of the ear with india ink. The instrument for making the punctures is arranged so that any combination of letters or figures may be used. In using this the skin of the ear should be thoroughly cleaned of grease by washing with soap or gasoline. The puncture is then made, and the tattoo oil thoroughly rubbed in. The figures show clearly after a few days, when the wound is healed, and remain permanently.

The plan adopted by the author is to mark every calf before it is taken from its mother. Each animal is given a permanent herd number, which is recorded, and a strap placed around its neck bearing this number on a brass tag. This tag is worn until the animal is nearly mature, and it is familiar to the attendants. The tattoo mark is put in the ear at the age of about one year, and while not suitable for identification at a distance, makes it possible at any time to positively identify the animal.

Sheltering Cows. The housing of the dairy cow naturally depends upon the climatic conditions. In regions with long hot summers and little cold winter weather the main problem sometimes is the protection of the animal from the sun during the heat of midday. Under these conditions sheds of inexpensive construction, open on all sides but protected against insects by means of netting, are used.

When cold weather is experienced during the winter, the question of protection against storm and cold becomes an important one. The most favorable barn temperature has not been determined experimentally, but according to Armsby it is between 40° and 50 F. for well fed cows and between 55 and 65° for growing animals and animals on maintenance. This is in accordance with practical observations. Experimental work and practical experience have shown that the fattening steer with a surplus of heat in his body does not need much, if any, protection from the cold further than a windbreak.

The cow, however, is not protected by thick layers of fat as is the steer, and she is far more susceptible to cold. Dairy cows and young stock should not be unduly exposed to severe weather, while cold rains and snowstorms are especially to be avoided. Cattle, when well fed, are not so sensitive to low temperature as is sometimes assumed.

The Pennsylvania Experiment Station for three winters compared the feed requirements and the milk production of two groups of cows, one housed in a well-built barn, the other kept in a shed open to the south. These trials showed that the cows kept in the open shed had keener appetites and consumed more roughage than those kept in the barn. The group inside averaged only 1 per cent more milk for the three years. The milk yield of the group in the open shed decreased somewhat more rapidly than that of the inside group. The outside group required more bedding, but less labor to keep clean.

Woodward and associates report a similar trial at Beltsville, Maryland, covering three winters. In this trial the cows in the open shed used somewhat more feed and produced slightly more milk than those kept in the closed barn. The increase in production, however, was not sufficient to offset the extra feed required. Slightly more labor and 68 per cent more bedding were required by the open-shed lot.

While it is clear from these results that it is easily possible to overestimate the detrimental effect of cold weather upon dairy cows, it should be kept in mind that these animals were fed liberally and were well protected even in the open shed from winds and rain and snow. The effects of turning the herd out of doors regardless of weather under conditions more comparable with those on the farm are shown by results from an experiment by Plumb. One group of cows were kept in the barn except for about one hour a day during mild or sunny weather. The second lot were kept outside in a barnyard eight hours each day regardless of weather conditions. Those outside regularly consumed 1.61 pounds of feed to each pound of milk compared to 1.48 by the inside group. The inside group produced 5 per cent more milk.

Summary. In cold climates cows should remain in the barn except for a few hours in the middle of the day when the weather is mild. On stormy days or during periods of excessively cold weather cows in milk will do best if kept inside constantly. In this connection the use of individual watering cups in the barn is especially to be recommended.

An abundance of fresh air is as necessary for the health of the cow as of any other animal, and should be provided without fail. However, it should be supplied by proper ventilation, and not through the walls of poorly constructed barns. Excessively warm weather is far more injurious to the dairy cow than cold, and there is no practicable means of making the animal comfortable under such conditions. For this reason hot weather and warm climates are not conducive to a high production of milk.

This is especially the case where high temperature is combined with a high humidity of the atmosphere.

Persistency in Production. A cow that maintains a medium production over a long period often makes a greater total production for the year than one that is much higher in the beginning but does not hold to this high level long. Persistency in milk production is partly the result of inheritance and is in part the result of feed and management. Frequently a cow that milks well at the start but declines rapidly does so on account of not receiving sufficient feed to supply the nutrients needed. She draws on her body reserve for a while, then when this becomes low declines rapidly in milk production. The feeder should especially concern himself to feed as liberally as necessary to supply the nutrients needed for the milk produced in order to hold up the production as long as practicable.

It is very important to understand that when the stimulation to produce milk is lost it is impossible to restore it. When a cow is allowed to drop in milk production as the result of insufficient feed it is impossible to bring the milk flow back to the point where it should be later by remedying the defect in feeding. For example, a cow calving in May and producing 45 pounds daily at the maximum in June should produce about 40 pounds daily in July and 35 in August. If allowed, as the result of poor feed, to drop to 20 pounds in August it is impossible by correcting the ration in September to bring the yield back to 32, the amount she should be producing at that time. The change to a good ration at this time will result in increasing the milk yield possibly to 25 pounds daily but the effect of the decline in August will be in evidence the remainder of the lactation period.

The successful herdsman makes sure that the dairy cow is so handled and fed that the decline in milk yield with the advance of lactation is no more than normal.

The Fly Annoyance. Cattle in this country are troubled mostly by two varieties of flies, known as the stable fly, *Stomoxus calcitrans*, and the horn fly, *Haematobia serrata*. The stable fly resembles the ordinary house fly in appearance; but while the house fly does not bite, the stable fly has mouth parts that enable it to pierce the skin and suck the blood of animals. The eggs are laid mostly in manure, horse manure preferably, but also in cow manure and in piles of straw which are fermenting and rotting. The period for development is about fifteen days from egg to adult fly.

The horn fly was introduced into America about 1886. It is considerably smaller than the house fly, and gets its name from the characteristic of gathering about the base of the horns. It is also recognized by the habit of feeding with the wings spread, and usually goes in swarms. Its bite is very irritating, and causes a congestion resembling the bite of a mosquito. The eggs are laid in fresh manure, and require about ten days to develop adult flies. These flies remain with the cattle constantly, roosting largely on the horns.

Since flies that annoy cattle are hatched mainly in manure, the first precaution to be observed in reducing the numbers to the minimum is to avoid an accumulation of manure where it will remain moist, and especially near the barn. Since horse manure seems to be preferred by these pests, special care should be taken not to allow it to remain in heaps near the barn. Where a small amount of manure accumulates, it is sometimes kept in a screened enclosure. When the weather is damp so that the manure dropped in the field remains moist a sufficient length of time, the flies hatch freely wherever droppings are found. In dry seasons this opportunity is reduced, and the number of flies is usually much smaller.

Fly repellents. The popular idea of the great injury done by flies has resulted in many proprietary mixtures being put on the market designed for the purpose of keeping off the flies. The compounds are usually composed chiefly of some coal tar product with the addition of fish oil, resin, or pine tar. These are applied to the animal with a hand spray pump. Great claims are made by the manufacturer regarding the injury done by flies and the profit resulting from using these repellents. Investigations made by at least three experiment stations have failed to show any advantages from their use.

Beach and Clark report a trial to determine the effect of applying one of these preparations on the milk and butter fat yield of cows. The trial covered two summers. They concluded that while the preparation they used protected the cows fairly well against the flies, the milk and fat production was not increased when the cows were sprayed. Their investigation indicates that the annoyance of cows by flies is overestimated.

The author conducted similar experiments for two summers. The cows were fairly well protected when the repellent was applied daily. However, no effect could be detected upon the milk and fat production. The only advantage observed was that the cows were less restless during milking.

Experience covering several years leads to the conclusion that unless used properly fly repellents do more harm than good. When used regularly the skin of the animal often becomes covered with a sticky gummy substance that apparently is more objectionable to the animals than the flies. When a repellent, which leaves a residue of this kind is used the cows should be washed often enough to prevent such accumulation. Mixtures for spraying cows may be prepared at home from materials purchased at the drug store, but those mixtures are generally less satisfactory than those purchased in the prepared form, and the saving in expense is not great.

The use of screens. The inexperienced often are surprised that screens are not used more generally on barns. Experience shows that screens on windows of a dairy barn are worse than useless unless some means can be devised of getting the animals into the barn free from flies. The trouble is that when the cows enter the barn a multitude of flies accompany them. While the animals are in the barn many of the flies leave the animals and go to the windows and are left behind when the cows leave. When the cows return the barn contains a large number of hungry flies which at once attack the animals and interfere decidedly with the handling and milking.

Screens should be used by all means on the milk room, and a double screen door provided between it and the barn. It will be found advantageous to have the screens open outward in order that the room may be cleared of flies during the day. A fan blowing a current of air over the milk strainer will keep flies away completely.

Decline in Milk Production in Summer. Under conditions typical for the greater part of the United States the average dairy herd produces milk in abundance in the early part of summer but during the latter part of the season declines very rapidly.

A compilation made by the author from the records of an Iowa creamery illustrates this point. Sixty patrons supplying this creamery sold only 46 pounds of milk on August 1 for each 100 pounds delivered June 1. At the same time, for each 100 pounds produced by the College herd June 1, 68 pounds were produced August 1. These figures from the farmers' herds represent the typical conditions, and the results from the College herd show that this decline in production as a result of the late summer condition may be greatly reduced by proper measures.

Causes of the decline in late summer. The cause of this rapid decline in milk production as the summer advances is the result of a combination of factors. The popular opinion seems to be that the annoyance from flies is the chief cause, but there is evidence that, while flies are a factor, it is overestimated. The dropping off in milk produced seems to be fundamentally a question of feed. The flies and the hot weather are factors in so far as they both discourage the animals from grazing as they otherwise would. Even if pastures are abundant the cows dislike to move in the hot sun and often spend most of the day standing in the shade.

In many regions a shortage of rainfall in midsummer results in an actual shortage of available feed in the form of grass. Furthermore, the forage which is on hand is less palatable on account of a greater maturity of the plant.

The reason for believing that the effect of flies is overestimated is the experimental results which show that no appreciable increase in milk results from spraying cows daily with fly repellents which keep the flies away reasonably well. That the question is mainly one of feed is further borne out by the experience that when cows are given an abundance of feed so they can get it without effort there is but little tendency for an abnormal decline in milk production to occur. Only too often the condition of the pastures in midsummer offers sufficient reasons for the poor results obtained.

The final result is that the cow, especially if producing a liberal amount of milk, consumes an insufficient supply of nutrients to maintain her production. As a result she loses flesh on account of taking material from her body for a time to supplement the food received. A dairy cow with a strong stimulation to produce milk will do so for some time even if the feed is insufficient, but soon the production declines, slowly at first, then more rapidly as conditions become more extreme.

Maintaining the milk flow in summer. As pointed out elsewhere, one of the highly important factors in securing a large milk production for the year is to prevent premature declines, as it is impossible to bring an animal back that has once been allowed to decline on account of poor feed or treatment. For cows that freshen in the spring, especially, it is highly important that the milk production be kept up during midsummer even though it may not pay financially at the time to do so; since if allowed to drop at that time it cannot be brought back to the point where it should be, and the result will continue to the end of the milking period.

The plan to be adopted to maintain the milk flow during this period will depend upon a number of conditions. First of all, if the cows are on pasture they should have opportunity to graze during the hours of early morning and late evening. It will be observed that during hot weather the animals graze but little during the day, preferring to stand in the shade or a pool of water. As a result they come to the barn hungry, and if kept over night in a dry lot, as is often done, but little grazing is done.

The plan has been recommended by some of housing the cows during the day in a darkened barn to avoid annoyance from flies, letting them out at night to graze. The objection to this is the difficulty of keeping the stable dark and at the same time cool and comfortable. Again, the extra expense of labor in cleaning the stable and supplying bedding makes it impracticable in most cases.

Supplementing the Pasture. Keeping in mind the conclusion that the problem of maintaining milk production in summer is largely that of furnishing a suitable feed supply easily accessible, the question arises as to the best and most economical means of meeting this demand. Some depend upon feeding concentrates for this purpose. In certain localities it is the practice to depend upon soiling crops. There is a growing belief that over wide areas the use of silage is the most practical means of supplementing pastures.

The question of grain feeding in summer is considered in detail in connection with the discussion of feeding. It may be stated here that the use of grain is an effective means of holding up milk production when confronted by the unfavorable conditions of middle and late summer. However, it is an expensive practice to the extent that the grain replaces the grass. Under very poor pasture conditions the roughage consumed by the cows from the pasture may be insufficient even when rather heavy feeding of grain is practiced, and some dry roughage may be necessary.

The use of soiling crops, that is crops grown to be cut and fed green, serves the purpose of supplying good roughage in place of grass. The objections are the labor expense of cutting and hauling heavy green material daily and the difficulty of having suitable crops ready at the time needed.

The Summer Silo. The use of silage for winter feeding has become almost universal among dairy farmers in those regions where suitable crops for the silo flourish. In recent years there is a tendency to lengthen the period of silage feeding and make use of a special silo for summer feeding. A silo for use in hot weather should be smaller in diameter than that required for winter feeding, in order that more may be fed off daily and by this means reduce the danger of spoiling. Silage may be kept without loss from one year to another and if not needed during the summer months the silo may be refilled in the fall after taking out the layer of rotten material which forms on top when the silage is not being fed regularly. Silage is not a complete ration for a dairy cow. It may be used alone to supplement pastures, but if the conditions are such that most of the feed has to be supplied outside of the pasture then the feeding procedure should be practically that of winter. A legume hay should be supplied as additional roughage and concentrates fed in proportion to the milk production.

Length of Time a Cow is Profitable. The dairy cow is mature in regard to milk production at five years of age. Between this point and the age of 10 to 12 years, age exerts no particular effect upon the amount of milk to be expected. Another factor having an important relation to the value of the cow in the herd is the relation of age to breeding. After the age of 10 years difficulties of this kind increase rapidly.

The market price of the grade dairy cow is usually the highest when she is three or four years old. At this time her first milking period, or possibly the first two, are completed and it is possible to judge as well as at any time in her lifetime as to her dairy qualities. She still has the best part of her productive life ahead. After the age of eight years is reached, her market value begins to decline even though she may be at her best in milk production. A decrease in value is clearly justified since her period of future usefulness is short on account of the decline in milk production that will come within three or four years, and the knowledge that fully one-third of all high-class dairy cows fail to breed when past 10 years of age. On the average in the grade herds of the country, a cow is milked between five and six years, although in every herd of any size a few will be found that have been in use for ten years. This rapid replacement is due in part to a considerable number being eliminated as unprofitable producers; others have udder troubles, and some develop difficulties in breeding.

In order to have a basis for a decision as to when a cow is no longer profitable, records of milk production and of breeding should be kept. The inferior producers will be sold regardless of age. The high-producing cows, however, if they continue to breed, should be kept until at least between ten and twelve years of age.

CHAPTER XXII

CARE AND MANAGEMENT (*Continued*)

Giving the Cow a Rest. The production of a liberal amount of milk is a severe tax upon a cow. Even the very moderate amounts of 6,000 pounds of milk in a year means the manufacture of 750 pounds of dry matter, or more than the total dry material in the carcass of a steer weighing 1,250 pounds. Experience has shown that a cow will produce more milk in a year if allowed to have a dry period of six weeks or two months than she will if milked continuously. For this reason the universal practice among experienced herdsmen is to allow this interval for restoring the physical condition preparatory to the labors of the following year. Under ordinary conditions the cow should be dry six weeks at least, and if in poor flesh, two months is better.

As a result of recent investigations in nutrition it is probable that the special value of the dry period is to allow the animal to recuperate the mineral supply of her body, especially the calcium which is drawn upon during heavy milk production. A cow that is not given a rest before calving will begin her milk production at a much lower level than will be the case when she has had opportunity to recuperate, and as a result the milk production will be at a lower level throughout the entire milking period.

The belief is often held that milking a cow up to the time her calf is born will result in the calf being weak and small from lack of proper nourishment. This assumption is not borne out by experimental observations. The mother and not the calf is the one to suffer. The nourishment of the fetus comes from the blood of the mother and this fluid always remains practically the same in composition.

Drying off the Cow. With a large proportion of the cows used for dairy purposes more difficulty is experienced in keeping them milking as long as desired than in getting them to take a rest. However, many of the highly developed dairy cows will milk continuously unless dried up intentionally by the owner. With such animals difficulty is sometimes experienced in getting the secretion of milk stopped. Occasionally the excuse that she should not be dried off is given for not giving a cow a rest before freshening.

There seem to be two factors causing a cow to secrete milk. One is an internal stimulation of the class known as hormones. This substance produced somewhere in the body stimulates the udder gland to activity. The other factor is the nervous stimulation from the act of milking. In the early part of the lactation period the internal stimulation is strong and at this time it would be hard to dry up a cow. After several months in milk the internal stimulation declines, and the secretion comes to be largely the result of the stimulation resulting from the act of milking. These facts have an important bearing upon the question of drying off the cow.

The common method of drying a cow is to lengthen the interval between milking by omitting one milking each day. After a few days the milk is drawn only once in two days, until secretion is completely stopped. This may require two weeks or more.

There is far less danger of injuring the cow's udder in drying her up than is generally believed. After the cow has passed the eighth or ninth month in milk the continuation of milk production depends largely upon the stimulation from the act of milking and she will soon cease to secrete milk if this stimulation is removed. If a cow is producing as little as 10 pounds per day, milking can be stopped at any time, and no harm will result. The udder should not be milked out at all. It will fill up for a few days, and then the milk contained is gradually reabsorbed, and no harm will result in any case. If a cow is producing more than this amount of milk, it is advisable to first cut down her feed. The grain ration should be all removed and a poor quality of roughage low in protein supplied for a few days. With this treatment the production will decline rapidly, and when it reaches a level of 8 to 10 pounds daily the milking may be discontinued entirely.

If, through some oversight or otherwise, a cow is continued in milk until within about three weeks of the date she is due to freshen, the milk production begins to increase gradually and it is more difficult to dry her up than if it is begun about two months before the date for freshening. It is hardly advisable to attempt to dry up a cow if within ten days or two weeks of freshening—she shows the usual tendency to increase in milk production under these conditions.

Management of the Dry Cow. The physical condition of the cow at time of freshening has a distinct relation to the milk production for the entire lactation period. Experience shows that if a cow freshens in a poor physical condition as the result of not having been dry long enough, or because of poor rations for a period preceding, she starts considerably below her normal level of milk production and no amount of care in feeding and management later will bring her up to the level she would have reached had she been in proper condition.

For example, a certain cow may have the capacity to produce 40 pounds of milk daily when fresh, provided she is in good condition. If she is allowed to freshen in a poor condition she may never exceed 30 pounds daily and will decline at about the normal rate, resulting in a lower daily production, not only at first but even after six months in milk. Fig. 65 based upon actual results shows what may be expected. In this case when the cow was in good condition she produced 36 pounds daily at her best and a total of 6,544 pounds for the year. At another time, as the result of freshening in poor condition, she followed the lower curve, producing a maximum of 27 pounds a day and a total of 4,468 pounds for the year.

Additional reasons for having the cow in good condition is that less trouble will be experienced in parturition and from the retention of the afterbirth. Those who recognize the practical importance of feeding the cow will, during the period preceding calving, sometimes make the error of assuming that the reason for liberal feeding at this time is the necessity of supplying nutrients for the development of the fetus. The tax upon the mother to develop the fetus is really very small, too small in fact to be measured in feed nutrients required. A calf weighing 70 pounds at birth contains only 17 pounds of dry matter. A cow producing 140 pounds of average milk produces as much dry matter as is found in a calf at birth.

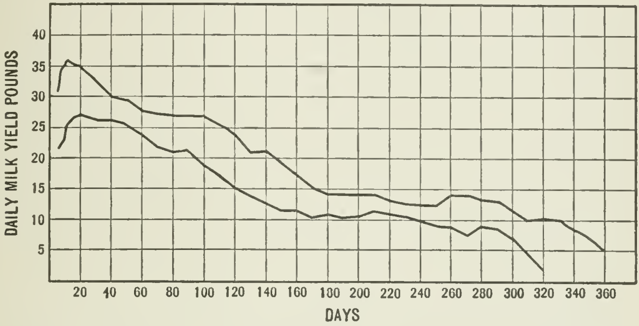


FIG. 65. Relation of physical condition of the cow at parturition to milk production

The upper line on the chart represents the milk production of a certain cow during a lactation period. When started, she was in good physical condition. She produced 36 pounds daily at her best and 6,544 pounds for the year. Another year she freshened in poor condition and produced milk as shown by the lower curve. Her best this year was 27 pounds daily and 4,468 for the year. Note at no time following the poor start did she reach the production of the other year.

Another assumption sometimes made is that if the cow is not fed well preceding the calf-birth the calf will be undersized. Experimental work has shown that the feed received by the mother has no effect whatever upon the size of the calf unless conditions of feeding are followed far more extreme than are found under practical conditions. It should be recognized that poor feed and management, resulting in a low physical condition at time of freshening, are not measured by the effect upon the calf but upon the cow and her level of milk production during the lactation period which follows.

Rations for the Dry Cow. The feeding of the cow while dry will depend largely upon her condition of flesh when she goes dry. If she is in good order, that is somewhat more than moderate in flesh, a little more than a good maintenance ration will be needed while dry. There is no more suitable ration for such a cow than good pasture or legume hay and corn silage. If she is thin, the ration should be sufficient to insure that she will be in proper condition at calving time. There is no special grain mixture to be used for the dry cow. The same ration as fed the cows in milk should meet all requirements. A suitable combination would be equal parts of corn meal, oats. bran, and oil meal.

About two weeks before calving, her grain ration, if heavy at the time, should be reduced to from 2 to 4 pounds daily and should be of such character as to maintain a laxative condition. Many skilled herdsmen give a dose of epsom salts at the first signs of calving.

The dry cow should have some exercise and nothing is better for this purpose than freedom in the pasture. She should not be driven by dogs or driven through narrow gates.

When cows are placed on official test the feeding during the dry period should be especially liberal as it has been found that having the cow in a high state of flesh at time of freshening is one of the first essentials in getting a good milk and fat record.

Milking before Calving. With some very heavy milkers the udder becomes so distended before parturition that the breeder especially if inexperienced, is often afraid that injury to the cow will result if she is not milked. Milking before the birth of the calf should seldom, if ever, be practiced. It is evident that an animal may suffer under these conditions from the great distention of the udder, but no fear need be felt that injury to the udder will result if she is not milked. Milking previous to the birth of the calf tends to delay the onset of parturition on account of the close relation between the nerves of the udder and of the reproductive organs. Sometimes as the result of milking, parturition may be delayed for a week or more and when it does come the contractions of the uterus which expel the fetus are weaker than normal, resulting in more trouble in the delivery of the calf.

Care of the Cow at Calving Time. If the cow has been dry for a time and has received sufficient feed, so she is in good condition at calving time, complications will not be frequent. If the cow is on pasture, she should be allowed to remain there, but looked after at least twice a day when about to calve. If not on pasture, the cow should be turned loose in a box stall of sufficient size several days before she is expected to calve. The stall should be thoroughly cleaned and disinfected before being occupied. As the time of parturition approaches, the udder becomes distended and hard, and filled with colostrum milk. When the tendons and muscles relax, leaving a hollow appearance on either side of the tail head, parturition may be expected within 24 hours, or three or four days at the longest.

The cow should be left strictly alone at time of calving, unless some assistance is evidently necessary. As a rule the calf will be born within half an hour. If the calf is not expelled after an hour or two, an examination should be made. The normal position of the calf at the time of delivery is front feet first with the front of the hoofs and knees upward while the nose lies between the knees. If the condition of the calf is normal, the cow may be assisted by pulling on a rope attached to the fore feet of the calf. This must be done carefully and only when the cow strains.

If the position of the calf is abnormal, that is, if it is coming hind feet first or the head doubled back, or any other abnormal condition is presented, the owner should waste no time in securing competent assistance. The services of a qualified veterinarian should be secured at once.

Retention of the Afterbirth. The cow is especially subject to retention of the afterbirth, and special attention must always be given that it comes away. When the cow is in good condition, the afterbirth is usually expelled within a few hours after the calf, often almost immediately. Cows far along in years, in low condition of health, or following abortion, are especially subject to this trouble.

The water given the cow following calving should be warmed as it is believed the drinking of very cold water, or exposure to cold weather, results in premature closing of the uterus. The afterbirth when expelled should be removed to prevent the animal from following her instinct and eating it. If the afterbirth is not expelled, a serious condition of the cow is brought about by the decomposition of the tissues within the body and the absorption of the poisons. A cow in such condition becomes emaciated and produces but little milk, and that is not in fit condition for food. This condition is easily known by the fetid products that escape, and the offensive odors that may penetrate the entire barn.

The cow should be so handled that retention of the afterbirth will be prevented as far as possible. However, it will occur frequently in all herds. The following advice concerning retained afterbirth is quoted from Dr. W. L. Williams: "There is general confusion about the handling of retained afterbirth and dairymen frequently ask what they had best do. The best course to pursue is to call a skilled veterinarian, and the next best thing is to let the afterbirth alone. There are few conditions that call for greater skill and judgment on the part of the veterinarian. It is utterly impossible for one who has not examined an animal to say whether a given afterbirth should be removed, or, if it should be removed, when. Sometimes an afterbirth may be removed with some advantage, but in such it would have come away itself a few hours later. Thus the removal is generally not highly important.

"In many cases it is impossible to detach properly a retained afterbirth from the cotyledons, or 'buttons' at any time. Instead the cotyledon dies and sloughs off the uterus. Then the afterbirth, with the dead cotyledons, comes away or must be removed altogether. When they are to come away can be learned only by examination. Sometimes the cotyledons are already sloughed away when abortion takes place. It may be eight to ten days or more after calving before the sloughing is completed. Any effort to remove an irremovable afterbirth is highly dangerous. Unless the person in charge knows what to do in a given case, the safest course to pursue is to carry into the cavity of the afterbirth as far as possible an ounce capsule of iodoform or iodoform and boric acid, and leave it there to prevent in a measure the putrefaction of the membranes while they are becoming detached. Beyond this nothing should be done except to keep the exterior of the cow washed, as a matter of general neatness. Retained afterbirth following abortion or premature birth is to be handled the same as when occurring with calving at full term."

Care of Cow after Calving. It should be borne in mind that the vitality of the cow is low following parturition, and she should be treated accordingly. She should be protected from cold drafts, and in case of severe cold weather it is well to cover her with a light blanket for a day or two. The water given her should be warmed for two or three days. The ration for the first few days should be light in character and not very abundant. A bran mash made by moistening bran with warm water is well adapted for the grain portion. With this can be given such amount of hay as will be readily eaten. If the udder is swollen and hard, the grain ration should be increased very slowly until this condition disappears, when more feed can be added, using as a rule two weeks at least, and with a heavy milker still longer, to get her on to full feed. No alarm need be felt if the udder remains inflamed and somewhat hard for a number of days, provided milk can be drawn freely from each quarter. The cow should be milked at least three times daily, or oftener, until the inflammation leaves the udder.

Guarding against Milk Fever. Milk fever occurs only with high-producing cows. It never occurs following the first calf or a heifer. It affects mature cows, and especially the heaviest milkers. In recent years the practice has become general, especially with high-producing cows liable to have milk fever, of milking out a little milk at a time several times during the day until the danger of this trouble is past. Only sufficient milk is drawn to relieve the extreme pressure, as it is believed advantageous to leave enough milk in the udder to cause considerable pressure during the dangerous period. When the age and condition of the cow suggest danger from this source a careful watch should be kept of the animal, especially during the first 48 hours, and to a less degree for a few days more.

The first indication of milk fever is uneasiness, a dull staring eye, and an unsteady gait. Within an hour or two the cow is down and soon becomes partially or totally unconscious and assumes a characteristic position, lying with her nose pointed back toward her flank. Often the cow will be in the unconscious state when first discovered. Anyone responsible for cows liable to have milk fever should either have a suitable outfit at hand at all times for treating it with the necessary knowledge of how to use the apparatus, or should at once call for the services of a competent veterinarian. Further details concerning the treatment of milk fever are given in the discussion of disease.

Care of New-born Calf. After the calf is born the mother should be allowed to lick it dry. If the weather is very cold or the mother does not seem disposed to lick the calf vigorously, it is advisable for the herdsman to assist in cleaning and drying the calf, using a piece of burlap or other coarse cloth for the purpose. The navel cord should be disinfected to the body by dipping it into a cup containing tincture of iodine or by painting the iodine over the surface.

If the calf is strong and vigorous it will be on its feet and nursing within a few hours. In case it is weak and does not take milk after three or four hours it is well to give some assistance by holding it up to its mother. The calf should have the first or colostrum milk, but if this is impossible on account of sickness of the dam, and milk is used from another cow, about an ounce of castor oil may be given with advantage to assist in cleaning out the digestive tract.

While the calf is still with its dam it should be marked according to the system in use in the herd. If the calf is to be registered later it is wise also at this time to prepare application blanks, including the sketch of color markings.

It is generally best to take the calf from its mother at the end of 24 hours and place it in an individual stall until strong enough to hold its own with larger calves. The care and feeding from this point is explained under the title of "Calf Raising."

Developing Long Milking Period. Persistency in milking is mostly a breed and individual character, but it is believed by some that it is possible to influence the length of time a cow will give milk each period during her life by the length of the first milking period. This possibility has never been studied experimentally and there is some reason for questioning if the length of the lactation period is so easily determined. A more reasonable view would be that persistency in milk secretion is an inherited characteristic. It is possible in those cases where cows with a tendency for a short lactation period are thought to develop this characteristic as the result of having been dried up too soon when a heifer—that the short milking as a heifer was likewise the result of inheritance and the question of forming a habit does not enter into the question at all. However, in view of the common belief and the lack of any experimental evidence, it is well to milk a heifer in her first lactation period as long as she should be milked when mature, even if the milk secured does not justify the time.

Water for Cows. Cows that are producing milk require a much larger quantity of water than is necessary for growing animals or for those that are merely being maintained, as in the case of wintering breeding stock of the beef breeds. This is caused by the necessity of providing water to be used in the milk itself and for the digestion and assimilation of a large quantity of feed, much of which is roughage.

The author found that a Jersey cow producing 27 pounds of milk daily consumed 77 pounds of water. Another of the same breed producing 13 pounds of milk used 40 pounds of water. A Holstein cow producing an average of 110 pounds of milk daily consumed from 215 to 350 pounds of water daily during the seven days covered by the data. These figures bear out the results obtained by others and indicate that the cow uses water at the rate of about three pounds to each pound of milk produced.

The character of the ration has some effect, as might be expected. When green feed or silage is fed the water consumption is not as great as when the ration is confined to dry hay and grains. The marked difference in the demand for water by the cow in milk and the animal on maintenance is shown by additional figures taken of the water consumption by the same Jersey cows when dry. Under this condition she used 15 pounds of water daily compared to 77 when producing milk and the other 9 pounds as against 40 when producing 13 pounds of milk daily. As shown in these figures, the large water requirement by the cow in milk, suggests, as has been found by practical experience, that it is exceedingly important to supply an abundance of good water to cows producing milk. It is evidently much more important that an abundance of water close at hand, and not too cold, be supplied to heavy-milking cows than is the case when the animals are on maintenance only. Cows that are not producing milk do not need to be watered more than once a day in the winter time, and at this season they do not seem to care for it oftener than this. In the summer the consumption of water by cattle on maintenance is greater on account of the greater evaporation from the skin; and while cattle will thrive when watered once per day, they relish it oftener and will do better if supplied twice per day. Cows on heavy feed and producing large quantities of milk should always have access to good water at least twice per day at all seasons. For the best results with dairy cows, water of good quality should be supplied close at hand, since if they be required to walk a long distance in cold weather, on account of the discomforts of exposure, they will not drink a sufficient amount to supply the demands of the body and will give a smaller amount of milk than they otherwise would, on account of not having consumed a sufficient quantity of water. In other words, the cow may suffer for lack of suitable water just as easily as for lack of feed.

The best source of supply for drinking purposes for dairy cattle is deep well water pumped into a tank or cement trough. Next to this are running streams or springs. The use of ponds as a means of supplying water is not objectionable if they are so placed that there is no drainage from barnyards or about dwellings, and if the animals are not allowed to wade into the water. Ponds which are filled with contaminated drainage water or in which stock of any kind are allowed to wade and pollute with their own excrement, are entirely unsuitable as a source of water supply. Not only should the use of such water be avoided for sanitary reasons, but the amount of water consumed under these conditions is liable to be below the real requirement of the body.

Watering Cows in the Barn. One of the most useful features of modern barn construction and equipment is provision for watering the dairy herd in the barn. The outstanding advantage is the possibility it affords for the cow, requiring as she does such large quantities of water, to drink a small amount at a time and at frequent intervals. There is no question but that when the plan is followed of watering at an outside tank once or twice a day, the heavy producing cows during the winter especially often fail to consume as much water as they need for best results.

The economy of labor is also an important factor to be considered, because provision for watering inside avoids the necessity of turning the cows loose for the purpose of watering. The first plan introduced for watering in the barn was that of building the manger in the form of a continuous trough with a drain to carry away the surplus. When the cows were to be watered the manger was swept clean of feed and filled with water. This plan has its advantages but is also objectionable from the standpoint of the spread of tuberculosis, and at the best it is only practical to offer the animals water twice daily. In recent years the plan has become general in well equipped barns to provide individual drinking cups. These are constructed so that the animal opens the valve by pressing with the nose or by raising the cover and water continues to run so long as she drinks. When the animal drinks small quantities at a time the necessity for warming the water is removed.

Perhaps no part of the modern barn equipment yields more return on its cost price than well constructed individual drinking cups. When properly installed about the only difficulty experienced is from freezing, if the barn is not so constructed as to keep the temperature above the freezing point.

Warming Water for Dairy Cattle. In climates where the temperature remains below freezing for long periods it is profitable to use some means of warming the water when the animals drink from a tank out doors. In addition to the minor advantage of having the tank free from ice the chief value of warming the water in the outside tank is to insure that the cows will drink a sufficient amount. A heavy-producing cow requires from 70 to 150 pounds of water daily and will not consume a sufficient amount if near the freezing point.

Assuming that a cow producing 40 pounds daily was watered twice a day, each time she would find it necessary to take about 60 pounds of ice water into her stomach. The effect upon digestion and milk secretion of such a volume of cold water is bound to be detrimental.

Formerly the economy of saving feed by warming water was emphasized. It is undoubtedly cheaper to warm water with a tank heater constructed for the purpose by burning coal or wood than it is to supply the same amount of heat by allowing the animal to burn up high-priced feed in its body. However, the present view is that a heavily fed cow has some surplus heat that may be used for warming water if necessary, and therefore the saving in feed by warming the water may be easily overestimated. However, the first reasons given are alone sufficient to justify making suitable provision so that no dairy cow will be required to endure the exposure to storm and cold and to drink ice water. If she receives this treatment her owner will pay the penalty in a production far below what it might be.

Salt Requirements. All animals that consume large quantities of vegetable food require salt. Carniverous animals do not have this craving, neither do human beings that live mostly upon meat. According to Bunge the cause of this salt requirement by herbivorous animals is the large quantities of potassium which they consume with the plant food. The potassium is excreted through the kidneys, but while it is in the body a reaction takes place between the potassium and the sodium chloride or common salt, and the resulting compounds are excreted from the body. This leaves the body short in the amount of sodium chloride needed, and results in the well-known craving for common salt, or sodium chloride. Common salt is needed, according to this view, to help expel the excess potash taken in with the vegetable food.

Babcock's investigations. Babcock has reported extensive investigations on this subject. He kept cows in milk without salt for periods up to one year. The composition and the quantity of the milk produced was not affected by withholding salt for short periods. Cows without salt showed a strong craving for it after two or three weeks, then quieted down and gradually changed into a condition of low vitality, rough coat, and emaciated condition, which resulted finally in a complete breakdown. In most cases the cows recovered their normal condition when given an abundance of salt. He found that cows consume about one ounce per day when allowed to eat as their appetite demands. He concluded that ¾ ounce per day per 1,000 pounds live weight is sufficient, with $\frac{6}{10}$ ounce in addition for each 20 pounds of milk produced. Babcock's investigations indicate that the chlorine is the essential element supplied by salt.

Feeding of salt. Practical observations and scientific investigations agree that salt is an essential part of the ration for the dairy cow. Salt may be supplied by mixing the proper amounts regularly with the feed, or it may be placed where the animal can consume such amounts as the appetite demands. From one to three ounces per day is needed, depending upon the amount of milk produced. Some feeders prefer rock salt, in which case a lump is placed where it can be licked by the animals as their appetite calls for it. The common plan of salting the cattle only at intervals of one or two weeks is not to be recommended.

CHAPTER XXIII

MILKING FACTORS INFLUENCING THE QUANTITY AND QUALITY OF MILK

MILKING

Milking the Heifer. If the heifer is properly handled before she has her first calf, there is little difficulty in teaching her to be milked. If the heifer has been tied while being fed as a calf, there will be no further trouble about tying her at any time. The heifer should be accustomed to the stable where she is to be tied for some time before she calves. It is best to tie her for a month or more before she freshens in the stall she is to occupy when in milk, and to make a point of handling her daily. A careful man should have the milking of her at first, and must go about it carefully and without exciting her. Very little trouble will ever be experienced under such conditions. The men who care for cows should always move about among them gently and not startle them by sudden movements or loud talking.

Methods of Milking. Milking is generally considered such a simple operation that any common laborer is supposed to be able to milk. However, there is an immense difference in milkers, and one of the most difficult parts of carrying on dairy farming is that of securing competent men to do this work. One milker may be able to get 20 per cent more milk than another, one may dry the cow within a few months, while another may keep her in milk the entire year. The milker should not be allowed to excite or worry the cows by loud talking or cruelty or abuse of any kind.

The secretion of milk is involuntary, but may be affected indirectly by excitement of any kind. Even the presence of a stranger or a dog at milking time is sufficient to affect the milk yield of many cows. The changing of milkers results in some loss for a few milkings, unless the new milker is better than the former.

A cow should be milked quietly and quickly. A cow is largely a creature of habit. If usually fed at the time of her milking she cannot be milked satisfactorily until she has her feed. Special care should be taken to secure all of the strippings. The first milk drawn may contain as little as 1 per cent of fat, while the last drawn runs from 6 to 10 per cent. In milking, the whole hand should be used, closing first that part next to the udder; then the milk is forced past the sphincter muscle by closing the remainder of the hand. The milking should not be

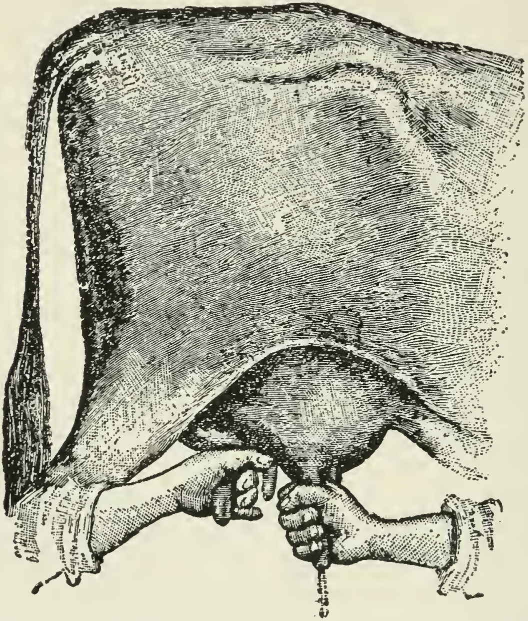


FIG. 66. Correct position of the hands when milking (Grotenfelt)

done by using the thumb and forefinger alone, neither should the thumb be enclosed within the palm, as is sometimes done. The cow's teats should always be dry when milking. Wetting the teats not only is a dirty, filthy practice, but it also allows the teats to chap and become sore in cold weather. If there is difficulty in milking dry, a small amount of vaseline may be rubbed on the hands. This serves the same purpose as wetting the teats, and is beneficial rather than harmful, both in a sanitary way and as it affects the cow's teats.

Milking More than Twice Daily. Under ordinary conditions the usual practice of milking twice daily is sufficient. The intervals between should be as nearly equal as possible. Occasionally there are conditions which justify milking three times daily even when the production of milk for market is the objective. Heavy-producing cows will increase their yield by an additional milking while small or medium milkers show no appreciable increase. Few cows will produce over 50 or 60 pounds, at the most, with twice-a-day milking. For the Channel Island breeds 35 to 45 pounds mark the same limits. With cows of this grade a third milking makes it possible not only to make use of the full capacity of the animal but also apparently to hold up the production to a high level for a longer period.

Riford[1] changed fifty cows averaging 45 pounds of milk daily from two to three-time milkings daily. The average increase was four pounds of milk daily. It was noticed that the fresh cows responded best. He later compared the milk produced by a group of 25 cows on three milkings daily with the best production in previous lactations with two milkings daily. The increase due to the third milking varied from 9.1 to 13.2 pounds daily. He concludes that the third milking adds about 10 per cent to the production of cows ranging between 40 and 50 pounds daily, while for those near 60 pounds the increase is about 20 per cent.

[1] *Hoard's Dairyman*, Vol. LXIII, p. 661 (1922).

Seventy or 80 pounds of milk daily for a Holstein or 50 for a Jersey is near the upper limit for three milkings daily. If the animal has a capacity above this, four milkings are necessary to obtain the maximum yield.

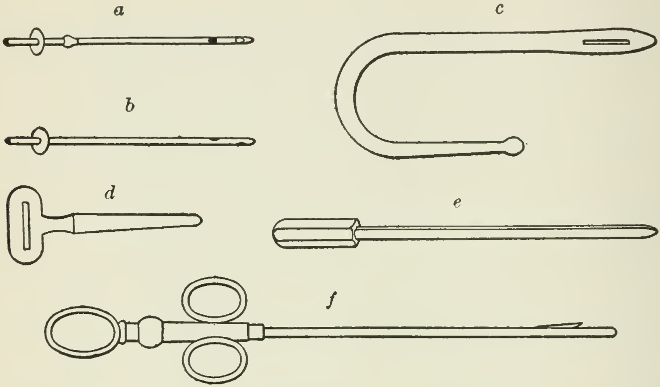


Fig. 67. Instruments for treatment of udder troubles. *a*, *b*, milk tubes; *c*, lead teat plug; *d*, teat expander; *e*, teat opener; *f*, teat slitter or bistoury

When a number of heavy milking cows are in a herd and other duties are not too pressing a third milking may pay liberally for the time required. When pure-bred cows are on official test and the object is to obtain the maximum amount of milk regardless of economy of labor three-times-a-day milking should be practiced for the greater part of the lactation period, and where the production is very high four milkings is the usual practice. The intervals between the milkings should be as near equal as possible, but if this is not practicable, milkings should be done regularly at the same hours. When the practice of three milkings is followed the highest fat test is usually found at the milking coming nearest midday and the lowest in the early morning milking. The early morning milking as a rule gives the largest quantity of milk and the late evening milking the lowest.

With four-times-a-day milking the highest fat content is usually found in the milking preceding noon and the lowest in the early morning. The highest milk yield is secured from the early morning and the lowest from the late evening milking.

Hard-Milking Cows. Some cows are considerable of an annoyance to the milker because they milk unusually hard. This is caused by a strong sphincter muscle, which closes the teat opening tighter than it should. Allowing the teats to become dry and harsh also tends to produce this condition. The use of vaseline or oil on the teats and milking by a milker with strong hands may partially remedy the condition. It is also possible to use teat plugs made of rubber or lead to expand the opening. When these are used they must be first thoroughly sterilized, then inserted into the teats after milking and allowed to remain from one milking to another if the cow is confined in a stall. This is continued until the muscles are somewhat relaxed. In some cases this treatment is not sufficient to cause a permanent enlarging of the opening. In other cases the difficulty in milking is caused by a hard lump in the base of the teat, which seems to drop down into the opening when drawing the milk. The only means of remedying this condition is by a surgical operation. A veterinarian who has had experience in dealing with such cases can remedy the trouble in many cases.

Use of the Milking Tube. One of the most useful instruments for the herdsman is the milking tube. Everyone having the responsibility of a herd should have a set containing at least three milking tubes of different sizes. It should be understood, however, that if these are used carelessly, serious trouble may result. The responsible manager of the herd should see that all instruments and medicines are kept under lock and key and used only under his immediate direction.

In case of injury to a cow's teat, such as wire cuts, or by having been stepped upon, milking not only is painful for the cow, but prevents the proper healing of the injury. Under such conditions the milk tube should be used until the injury is healed. Providing suitable milk tubes with careful provision for their proper use will remove the temptation for milkers to resort to the use of quills or even straws as is sometimes done, and often to the permanent injury of the animal.

Sterilizing Instruments. Before a milk tube, a teat plug, or any instrument is inserted in the opening of a cow's teat, it must be thoroughly disinfected. If this is not done, germs may gain access to the udder which may cause inflammation that will ruin the animal. Instruments should first be thoroughly cleaned in warm water, and preferably boiled. Before being inserted into the teat, they should be placed in a 5 per cent solution of carbolic acid, or in a rather strong solution of creolin, and should be inserted while wet with this solution and without being touched with the hand on the portion that enters the duct.

Cows with Leaking Teats. Some cows lose a portion of their milk by leakage from the udder between milkings. This is caused by the sphincter muscle having a weak contraction. No practical remedy has been devised for this trouble. Under conditions that warrant the small amount of trouble involved, the teat opening may be closed with collodion after each milking.

Bloody Milk. Blood in milk is more common than is generally understood. It may be often noticed in separator slime when its presence is not suspected in the milk. It is not an indication of disease or any unhealthy condition in the cow. It is caused by the rupture of a small blood vessel that allows blood to escape into the milk cistern or the milk ducts. In some instances certain cows have it at intervals for a number of months, but more often it appears but once or twice. It cannot be prevented or stopped, and the only thing to do is to reject the milk affected.

Chapped Teats. Sore teats may be caused by cold weather, milking with wet hands, or other causes of local irritation. When so affected the cow does not stand quietly for milking, on account of the pain. The trouble may be easily remedied.

The application of vaseline for a few times on the first appearance of the trouble will usually check and cure it. If chapping be severe, the teats should be thoroughly washed and softened with warm water, after which glycerite of tannin may be applied. An application of olive oil is also often recommended.

Warts on the Teats. Warts on the teats are often troublesome. They often disappear or are greatly benefited by applying vaseline or olive oil. If large, they may be cut off with a pair of sharp scissors and the spot touched with a stick of caustic potash.

Kicking Cows. Cows are given to few vices, and those are mainly due to faulty management. The most common vice is that of kicking when being milked. The cows always kick at first, either from pain or fear, and if not handled properly, this may grow into a habit. Under no circumstances should a man strike a cow that kicks. It does no good, and always makes them worse. Gentle measures, however, will not work with all cows, and some old cows that have been taught by mismanagement to kick cannot be cured by the best of care. Such animals should always be tied during milking. This is best done by taking a rather heavy strap with a strong loop. The strap is put around one leg above the hock, and the end drawn through the loop. The strap is then put around the other leg and buckled, so the two legs are held close together. The cow may struggle a little at first, but soon learns to stand quietly as long as the strap is in place.

Self-Sucking Cows. This vice is not very common, but it is annoying when begun, and difficult to stop. If an ordinary cow contracts the habit, the best advice is to sell her at once. The most effective method of treatment seems to be to put a bull ring in the cow's nose and hang a second ring from the first. This method was suggested by the Wisconsin Experiment Station and has been tried by the author with good success.

The Milking Machine. A satisfactory mechanical milker has long been one of the greatest needs of the dairy farmer. The wide opportunity offered for a successful device of this kind early attracted the attention of inventors. A German writer states that 29 different milking machines were known to him between the years 1877 and 1898. The reports of the Commissioner of Patents show that 127 patents on milking machines or parts were taken out in the United States alone between 1872 and 1905[1]. The successful milker of today is the result of a long period of development, as indicated by the figures given. The first really practical mechanical milkers appeared on the market between 1900 and 1910. Modifications and improvements were made constantly until within the past five years the development seems to have reached a point of approaching stability.

The use of milking machines has increased rather slowly as compared with that of some other types of machines for instance. A large number of designs have been put on the market for a time, only to disappear later. One of the discouraging things about the milking machine so far is that a large number of farmers, probably fully one-half of those who have installed them, have later discarded the machines. On the other hand, others who have used machines for several years are entirely satisfied and would not continue in the dairy business without them. This suggests that success in using a machine of this kind depends largely upon the operator.

Tests of the efficiency of machines of different types, the relation to the milk yield and to the sanitary condition of the milk have been made by several experiment stations and the United States Department of Agriculture. From these reports it is possible to arrive at a reasonably safe conclusion regarding the general working of these machines in practice.

It has been thoroughly demonstrated that milking machines will milk cows and that a skilled operator will do as efficient work as the average hand milker. It is questionable, however, if the milking machine is equal to a skillful experienced hand milker in the amount of milk secured. During the early part of the lactation period the cow apparently milks better as compared with hand milking than is the case later in the milking period. Most users have found it more difficult to hold up the yield of milk during the last part of the milking period when the machine is used. After a cow has been in milk for some months the stimulation to produce milk is partly the act of milking itself. Hand milking results in more stimulation of this kind than does machine milking unless followed by careful stripping.

---

[1] Lane, C. B., Bulletin 92, Bureau of Animal Industry, U. S. Dept. Agr. (1907).

The cow is not injured in the least and generally prefers machine to hand milking.

There is some danger in spreading infectious udder troubles by the use of the machine. Care must be taken to milk any cow last which shows any suspicion of inflammation of the udder, or better still, not to use the machine at all in such cases. A careful sterilization of the teat cups is always advisable, but especially so when there is any evidence of udder trouble.

Since the chief source of dirt in milk is the body of the cow from which it drops during milking, it would appear that the use of the milking machine by excluding this dirt would be an important factor in improving the sanitary condition of milk. However, surveys show that machine drawn milk usually is inferior rather than superior to hand drawn in bacterial content. This is the result of careless cleaning of the outfit. If the machine is properly cleaned and used, the sanitary condition of the milk is improved over hand milking; on the other hand, if not well cleaned, the milk is in decidedly worse condition.

A farmer considering the purchase of a milking machine will do well to visit farms where different makes are in use and observe their operation. It is also well to select a machine that has been on the market long enough to make certain that the defects have been discovered and corrected. The chances are also better that a company which has been manufacturing a machine for several years will remain in business, making it possible for the user to secure parts when needed. It is doubtful if a milker using the pipe line vacuum system is justified for a herd of less than 25 cows.

FACTORS INFLUENCING THE QUANTITY AND QUALITY OF MILK

The Breed. It is a well-known fact that the breed of the animal bears a distinct relation to the quantity of milk produced and especially to the fat content. Within a breed the variation in milk yield is far greater than that of the fat percentage. For this reason many individuals within a breed do not show the typical milk yield of the breed they represent. For example, while the Holstein breed has the highest average milk yield, the lower-producing animals within the breed are decidedly below the higher-producing or even the average animals of breeds that rank considerably lower in average production. Milk produced by individuals within a breed varies much less in composition than yield, and is generally fairly typical of the breed.

Table 52 gives the average per cent of fat by breeds as shown by advanced registry records and from a compilation made by the author from a large number of records published by experiment stations.

TABLE 52. RELATION OF BREED TO PERCENTAGE OF FAT AND TOTAL SOLIDS (FROM ADVANCED REGISTRY AND EXPERIMENT STATION RECORDS)

BREED	AVERAGE FAT PERCENTAGE ADVANCED REGISTRY	EXPERIMENT STATION RECORDS	
		PER CENT TOTAL SOLIDS	PER CENT FAT
Holstein	3.42	12.29	3.45
Guernsey	5.00	14.70	4.98
Jersey	5.35	14.90	5.14
Ayrshire	3.97	12.98	3.85
Brown Swiss	3.97		
Shorthorn		12.85	3.80
Red Poll			4.03

Size within the Breed. In general those keeping dairy cows primarily for the production of dairy products for sale prefer a cow medium to large for the breed. Most breeders of pure-bred cattle have the same view, but some—especially those breeding the smaller breeds—look with more favor upon the smaller type.

The cows that have made the largest milk and fat records have been without exception large animals for their breed. Woll has also shown that the highest production is found with cows that are large for the breed to which they belong. The indications are that the stimulation to give large quantities of milk may be inherited independently of size. An undersized cow with a great stimulation to give milk is limited in her capacity to digest food and cannot compete with a larger animal that has stimulation to give milk to the same degree and has also the capacity and strength to handle the feed necessary for high milk production. Size and strength then are desirable but alone do not indicate ability to produce milk. Selecting a dairy cow on the basis of size alone would be poor policy although high-producing cows usually have good size. There is no relation within the breed between the size of the animal and the richness of the milk.

Intervals between Milking. When cows are milked twice a day at 12-hour intervals the composition of the milk usually varies but little, although there is a tendency for the milk from the morning milking to be a little higher in fat content. If the intervals are unequal, as would be the case when the morning milking is done at 5 A. M. and the evening at 7 P. M. the yield of milk will be considerably higher in the evening following the longer interval and the fat content noticeably higher in the morning after the shorter interval. The variation in fat percentage may be from 0.5 to 1.0 per cent under conditions as mentioned. This variation must be understood when sampling milk for testing. A sample taken from a single milking may be very misleading.

Variation from Day to Day. Marked variations in the fat percentage often occur in the milk from the same cow from day to day. Sometimes the cause for such variations may be recognized, but our present knowledge of milk secretion is too incomplete to make a satisfactory explanation in many cases. Table 53 shows typical variations in the yield of milk and the fat percentage from milking to milking. Where either three or four milkings a day are shown the animal was under official test. The others represent ordinary conditions with two milkings a day.

Table 53. Variations from Milking to Milking in Milk Yield and Fat Percentage

Day of Test	Breed	First Milking		Second Milking		Third Milking		Fourth Milking	
		Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat
		Lbs.	%	Lbs.	%	Lbs.	%	Lbs.	%
1	Guernsey . .	5.6	4.0	7.7	5.0	6.0	4.6	6.2	4.1
2		6.8	3.4	7.3	5.3	6.3	4.9	7.8	6.0
1	Guernsey . .	5.6	4.0	7.7	5.0	6.0	4.6	6.2	4.1
2		6.8	3.4	7.3	5.3	6.3	4.9	7.8	6.0
1	Jersey	12.1	5.0	11.3	6.2				
2		13.6	4.2	11.5	5.2				
1	Jersey	13.0	5.1	7.5	7.0	11.7	5.6		
2		11.3	4.8	7.8	6.7	9.4	4.0		
1	Holstein . . .	24.2	3.7	28.4	3.8	26.2	3.7	25.2	3.7
2		27.8	4.1	26.6	4.0	25.9	3.6	26.0	3.6
3		26.0	4.0	24.3	4.1	23.2	3.6	25.2	4.1
4		23.1	4.0	24.9	4.2	24.2	4.1	22.8	3.7
1	Holstein . . .	19.5	3.4	21.1	3.0				
2		20.5	2.3	14.0	2.2				
3		24.7	3.4	14.0	2.4				

Examples could be given that show much wider variations. It is impossible to give any definite limits to the extent of the variations that may occur. It should be kept in mind in this connection, as pointed out in another paragraph, that certain variations in fat percentage especially occur with the hour of milking. For example, when a cow is milked four times daily the highest fat test usually comes at the milking preceding midday. For this reason when considering variations from milking to milking the comparisons should be made with other milkings made at the same hour. Compared in this way a variation of half of a per cent would be common and of a whole per cent not unusual.

Bitter, Rancid, or Stale Milk. It is not uncommon for the milk of certain cows to have an abnormal taste and odor. This trouble is usually experienced or most often attracts attention when one or two cows are kept as a family milk supply. Presumably the same condition occurs frequently in the milk of cows in larger herds, but it is not noticed on account of the milk's being diluted by mixture with that from others. This abnormal condition is limited with few exceptions to the cow that has been in milk several months and usually when she is advanced in pregnancy. It rarely occurs when the cow is receiving green feed. The milk has a peculiar taste described by some as salty, by others as bitter. After a few hours a pronounced odor of rancid butter is noticed. Milk in this condition is not in any degree unwholesome but so objectionable in odor and taste that it is worthless. The cream from such milk is churned with great difficulty and sometimes cannot be churned by any method that can be devised.

This trouble is not, like most abnormal tastes which develop in milk, caused by the action of bacteria but by an enzyme known as lipase which is secreted in the milk and which causes a decomposition of the fat resulting in the rancid odor[1]. Why it is produced at times is not known.

As a rule the cow producing the milk which develops this abnormal taste is overfed with concentrated feed. Reducing the grain ration to the amount actually needed by the cow and

[1] Palmer, L. S., Journal of Dairy Science, Vol. 5, pp. 201–11 (1922).

giving two or three doses of epsom salts at intervals of three days may assist in removing the cause. The only certain method of preventing the development of the condition in the milk is to heat the milk to the boiling point immediately after milking and then to cool as rapidly as convenient.

Seasonal Variation. Another factor causing variations in the composition of milk which is not generally recognized is the season of the year. Farmers selling milk according to the Babcock Test generally note that the test is lower in summer than in winter. The decline in test is usually noted soon after the cows are turned to pasture in the spring. Towards fall the test begins to go up slightly.

The mistake has often been made of assuming that this decline in test during the summer months is the result of the food. The fact that the test is the lowest during the period the grass is the best in early summer and that it shows a tendency to increase towards winter when grain feeding begins is easily interpreted to mean that the grass is the cause of the depression. Experimental work has shown that this is an error. The same decline in test during the summer and the increase in the fall has been found to occur in the same manner with cows receiving a typical winter ration throughout the summer and having no access to pasture grass. The tendency is for the tests to reach the low point in early summer, usually June, and the highest point in December or January.

Figure 68 shows the average fat test, by months, of groups of Jersey cows freshening in February, June, August, and November. These graphs show that the group calving in February reach a low point in June, then raise sharply towards winter. The group starting in June begins practically at the low point and increases toward winter. After December is passed there is a slight tendency to drop. This drop would be greater were it not for the counteracting effect of the tendency to increase towards the end of the lactation period. The group freshening in November starts at a rather high level and increases slightly to January, after which there is some decline to June, followed by a rapid rise to the end of the year.

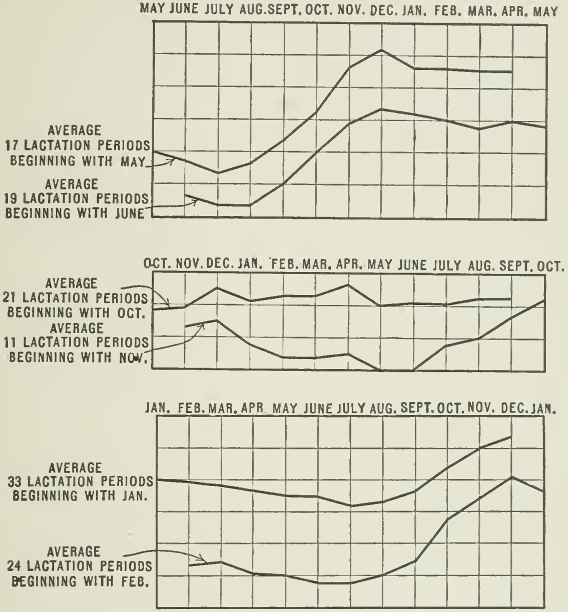


FIG. 68. The effect of season upon the fat percentage of milk

The fat content of milk tends to be highest in early winter and lowest in early summer as the result of temperature and humidity. Variations in the richness of milk due to this cause is often attributed erroneously to the influence of feed.

In studying these graphs it should be kept in mind that there is a strong tendency for the test to increase near the close of the lactation period. When this stage comes from August to January, when the test is also increasing due to the season, the raise in test is very rapid.

When the lactation period begins in June the seasonal effect during the end of the lactation period is towards a decline, while the influence of advanced lactation tends to increase the test. As a rule the test remains about stationary during the last four months of the milking period.

The effect of the season is apparently the result of weather conditions, especially heat and humidity. It is found that during a period of hot, humid weather the percentage of fat is depressed while if the conditions are the reverse, dry and cool, the test is increased. This intensity of the effect of the season exerted through the weather conditions varies with the locality. It is apparently more marked in the southern than in the northern part of the United States. Its practical importance is primarily that it explains the low tests of summer, which, as noted, are often attributed erroneously to the feed.

The results of the seasonal effects are especially noticeable with high-producing cows on official test. The summer tests under these conditions are often very disappointing. It also has a bearing on the best time of year to have cows freshen. It is found that fall calving gives a slightly higher test for the year than does spring calving, because it brings the highest milk yield and the highest test at the same time. For example, a certain Guernsey cow producing 40 pounds of milk when fresh tested 4.6 the first two months when she calved in the spring. When she calved in the fall she produced the same amount of milk, but tested 5.00 for the first two months.

Stage of Lactation and Milk Yield. The point during the lactation period at which milk production normally reaches its highest level, and the rate of normal decline are of concern to the practical herdsman. Considerable individual variation from any average is inevitable. Certain cows, as the result of inheritance, do not hold up in milk as well as others do. The important relation of feed should also be emphasized. Too often a cow is said to lack in persistency when she is really doing all she can with the feed received. The heavy-milking cow is often underfed when she is fresh because nature, to make sure the calf will not suffer, has arranged for the fresh cow to continue to give milk freely for a certain time even if deficient in feed, making up the deficiency from her body. The normal rate of decline in milk during the lactation period can be observed only when the cow concerned has at all times sufficient feed to supply the nutrients for the milk she is producing.

Table 54 gives data for two groups showing the average milk production by months during the lactation period.

TABLE 54. RELATION OF STAGE OF LACTATION TO MILK YIELD

MONTH OF LACTATION	25 COWS ON OFFICIAL TEST		35 COWS CALVING WITHIN 12 MONTHS	
	AVERAGE DAILY MILK YIELD LBS.	IN TERMS OF PERCENTAGE	AVERAGE DAILY MILK YIELD LBS.	IN TERMS OF PERCENTAGE
1	47.5	87.1	32.9	99.6
2	54.5	100.0	33.0	100.0
3	53.0	97.2	30.3	92.0
4	48.7	89.4	28.4	86.0
5	45.5	83.5	27.0	82.0
6	43.7	80.2	24.7	75.0
7	41.0	75.2	23.4	71.0
8	38.5	71.0	22.7	69.0
9	36.7	67.3	21.1	64.0
10	34.7	64.0	17.1	52.0
11	32.5	60.0	11.3	34.0
12	29.8	55.0	3.8	11.5

One group includes cows under official test conditions and the other represents good farm conditions where the animals freshen again within twelve months. The results are also expressed in terms of percentage, the highest month being represented by 100 per cent. Official test conditions include three or four milkings daily and delayed breeding. As a result of these conditions this group shows less decline as the lactation period advances. The results are also shown graphically in Figure 69.

It will be noted that the highest milk yield for both groups is reached the second month. From this point on to the eighth month the decline is much the same. From the ninth to the twelfth month the decline is decidedly more rapid for the group which calved again within the 12-month period. Cows that make exceptionally high official records for a year generally hold up somewhat better during the last six months than indicated by the average figures given. By using the percentage figures given, it is possible to estimate approximately what a certain animal will produce at different stages in her milking period. It should be kept in mind that these figures represent the special dairy breeds. Dual-purpose breeds are as a rule less persistent milkers and the rate of decline for these breeds is more rapid.

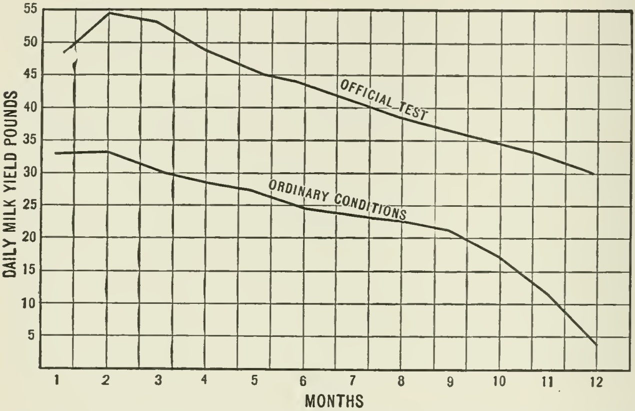


Fig. 69. The decline in milk production with the advance in lactation

The lower curve shows the typical decline in milk for cows under good farm conditions where they will freshen again within twelve months. Note the decline is quite uniform for the first nine months, after which it is more rapid. The upper curve represents a group of cows under official test conditions including three or four milkings daily, and delayed breeding. Note the uniformity of the decline after the high point is reached, also that the rate of decline is much slower than for the other group after nine months in milk.

Stage of Lactation and Fat Percentage. The influence of the stage of lactation upon the fat content of milk is often overestimated. Furthermore, it is influenced by several other factors.

Table 55 gives data which will serve as a basis for discussion. The data are illustrated in Fig. 70. These averages are made up regardless of the month of freshening, and the numbers included are large enough to eliminate the tendency to vary with the season. The first group includes 34 cows representing four breeds, and were kept under conditions typical of the best farm practice, and all calved again within 12 months. The fat content of the milk from this group remained practically the same for the first four months. From the fifth to the ninth month a slight increase is noted followed by a more rapid increase to the end of the milking period. In general, it may be said that under the conditions typical of good farm practice there is little if any increase in fat content until the point is reached where the decline in milk production is rapid.

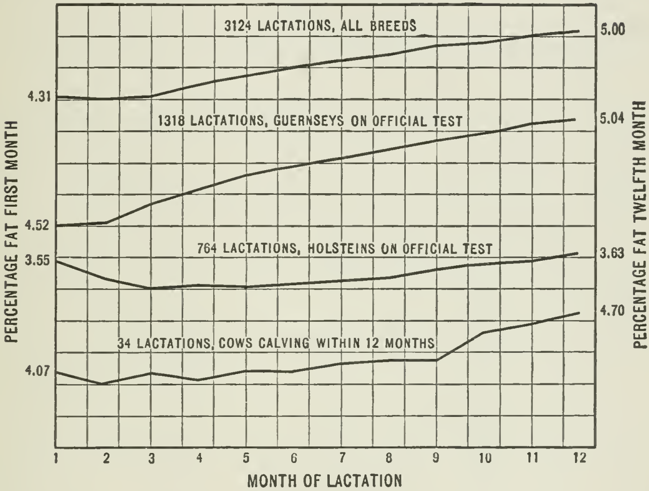


Fig. 70. State of lactation as a factor influencing the fat content of milk

The fat percentage increases somewhat as the lactation period progresses. The increase is especially rapid as the lactation period draws near its end, as is shown in the bottom curve. The bottom curve is typical for herds kept under the usual farm conditions. Records of individuals may vary from this curve as the result of the seasonal influence illustrated in Fig. 68.

Cows under official test conditions show a somewhat different result. The Holsteins—and the same is true for the Ayrshires although no figures are given—show a marked decline from the first to the third months, running about the same to the eighth month, after which there is a tendency to raise until at the tenth month the fat percentage is about on a par with the first month. The high fat percentage in the beginning is the result of having the cows in high condition as explained in another paragraph.

TABLE 55. RELATION OF STAGE OF LACTATION TO FAT PERCENTAGE

MONTH OF LACTATION	34 COWS CALVING WITHIN 12 MONTHS	764 HOLSTEINS OFFICIAL TEST	1318 GUERNSEYS OFFICIAL TEST	3154 LACTATIONS ALL BREEDS
1	4.07	3.55	4.52	4.31
2	3.94	3.36	4.56	4.28
3	4.06	3.25	4.76	4.35
4	4.00	3.29	4.90	4.44
5	4.10	3.27	5.05	4.54
6	4.10	3.29	5.15	4.62
7	4.17	3.34	5.23	4.69
8	4.20	3.38	5.32	4.76
9	4.20	3.47	5.42	4.85
10	4.50	3.52	5.50	4.88
11	4.59	3.56	5.60	4.96
12	4.70	3.63	5.64	5.00

Under official test conditions the milk production is still higher during the twelfth month which accounts for the slight increase in fat content. These same groups of animals would usually increase later to over 4 per cent during the period when the milk production is declining rapidly.

The Guernsey records made under official test conditions do not show the decline after the first month. For some reason this breed and the Jerseys as well do not show an increase in fat content of milk as the result of high conditioning in preparation for official testing. The last column shows an average of all studied, 3,154 lactation periods, some under official test conditions, others not. These show a slight decline from the first to the second month, followed by a gradual increase to the twelfth month.

As pointed out in another paragraph, the seasonal influence modifies the variation in fat content of milk materially and in fact is a greater factor than stage of lactation except for the rapid increase as the cow is going dry.

Effect of Gestation. It is a matter of common observation that a cow that is not bred or that fails to become pregnant holds up in milk production better than one that is carrying a fetus. The cattleman usually attributes this falling off in milk to the tax upon the animal commonly assumed to accompany gestation. This view, however is not borne out experimentally. The decline in milk production after the animal reaches about six months in gestation is the result of a substance produced by the reproductive organs, probably the placenta, which slows down and finally stops the secretion of milk.

The effect of gestation upon milk secretion begins to be noticeable when the period is about five months along. The effect of gestation upon milk production is shown in Table 56 and graphically in Figure 71. These data were compiled by the author from the records of 19 cows for which milk and fat records were available for a lactation period during which they were milked twice daily and bred to calve again within 12 months and for a second lactation period, when for some reason they did not become pregnant, and continued in milk for at least 15 months. The data show that these cows average 293 pounds of fat during the lactation period, which was followed by calving within a year, while the production was 349 pounds within the year when breeding was delayed. In this case delayed breeding resulted in 19 per cent more milk during the

12-months period. The production of the group where breeding was delayed would be decidedly the lower of the two the following year.

The Guernsey official test records show the average fat production of the single-letter class to be 7 per cent above that of the double-letter class. To enter the double-letter class a cow must calve within 75 days after the completion of the year's test, while no calving requirements are made for the single-letter class. The production for the 12-months' period evidently is not seriously affected when the interval between calvings is 14 months. Delayed breeding is justified when it is desirable to secure the maximum production, as when making official tests. When the production of market products is the object, the best plan is to have the cows freshen at intervals of about 12 months.

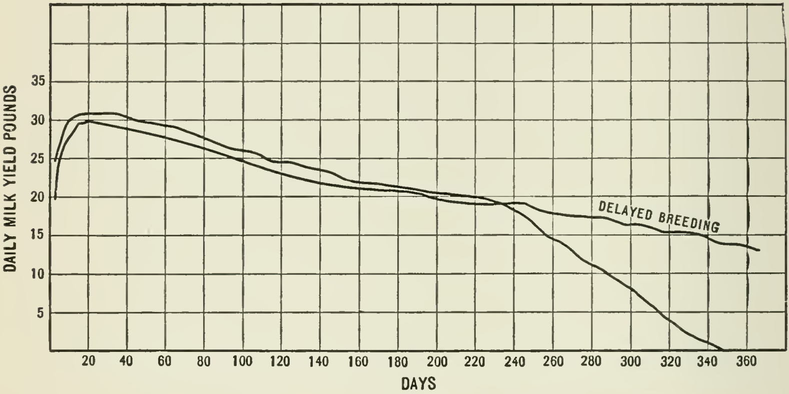


FIG. 71. Influence of gestation upon milk production

These two curves represent the decline in milk production during two lactation periods for a group of 19 cows. One year they calved again within 12 months. The milk production for this year is shown by the curve which starts above and ends below. The other year breeding was delayed and the same cows did not freshen again for at least 15 months. Note the production for the two years runs parallel until the end of the eighth month, after which the result of delayed breeding shows clearly. The delayed breeding resulted in 19 per cent more milk during the 12 months but the yield would be smaller the next 12 months.

TABLE 56. EFFECT OF GESTATION UPON MILK PRODUCTION

	CALVING WITHIN A YEAR	DELAYED BREEDING
No. Cows	19	19
Days in milk	305	579
Milk yield for entire period, lbs.	6,508	10,032
Milk yield 365 days, lbs.	6,508	7,650
Fat yield for entire period, lbs.	293	489
Fat yield, 365 days	293	349

Feed in Relation to Yield and Richness. The amount of milk a cow produces depends upon two things: the first is an internal factor which is the result of inheritance, and the second factor is the environment, that is, the feed and management. It should be kept in mind that feed alone cannot cause a cow to give milk beyond the limits of her inherited ability. The extent to which she can use feed for this purpose may be looked upon as the result of an internal stimulation. Within the limits of her inherited capacity the amount of milk is closely dependent upon the feed received and need not be discussed in detail here.

It would seem reasonable to assume that the richness of the milk would be influenced by the feed received by the animal. This question has received much attention by experiment stations in this country and in Europe, and the evidence is conclusive that the fat percentage of the milk cannot be changed permanently by any method of feeding. Certain experiments have shown that sudden changes in the ration—for example, greatly increasing the protein or oil content of the ration—may result in a small fat increase for a few days with some individuals—with others no effect is produced, and in any case the results are only temporary. No ration or method of feeding has been found by means of which a Shorthorn or Holstein can be made to give milk as rich as that of a Jersey or Guernsey.

Wing made an interesting study of the relation of liberal and scant feeding to milk production and fat percentage, covering four years and including 21 cows. A record of the milk production and the fat was kept for a lactation period on a farm where the feeding conditions were very poor. At the end of the period 10 of the cows were brought to the University Farm and fed liberally for two years; they were then returned to the farm and a record secured for the fourth year. The 7 cows that were continued the four years showed the following results:

	Lbs. Milk Yield	Fat Percentage
On farm, scant ration	3,340	4.40
University Farm, good ration	6,383	4.65
On farm, scant ration	4,492	4.43

The good feed and care resulted in nearly double the amount of milk produced under the poor feeding conditions on the farm. The result of the good treatment was carried over to some extent the following year when the herd was returned to the original farm conditions. The richness of the milk, however, was not increased to any appreciable extent by the better feed.

First and Last Milk Drawn. It is a well established fact that the first milk drawn contains a very low percentage of fat and that the last or the strippings, as ordinarily termed, are very rich in fat.

Table 57 gives a summary of data taken by the author from 7 cows representing four breeds and giving the results of a complete chemical analysis.

TABLE 57. COMPOSITION OF FIRST AND LAST MILK DRAWN

	Total Protein Per Cent	Sugar Per Cent	Fat Per Cent	Ash Per Cent	Total Solids Per Cent
First Milk	3.58	5.30	1.87	0.75	10.67
Strippings	3.38	5.33	6.28	.70	14.86

These figures show that the difference between fore milk and strippings is confined to the fat, and that this constituent shows a striking difference. It was also observed that the variation in fat content between fore milk and strippings is usually the greatest with heavy-milking cows.

The milk of a Jersey cow producing 36 pounds daily contained 1.59 per cent of fat in the fore milk and 5.9 in the strippings, while the milk from a cow of the same breed producing 7 pounds daily contained 3.07 per cent of fat in the fore milk and 4.91 in the strippings.

The practical value of these facts is to make it clear why the cow should be stripped when milked in order to secure the maximum amount of the high-testing milk. The last pint of milk drawn is equal to the first two quarts in fat contained.

Condition of Flesh at Calving. Good practice requires that the cow be in a strong, vigorous condition at time of freshening and have considerable surplus flesh as a reserve. The milk yield, especially in the early part of the lactation period, depends to a considerable extent upon this point.

Within the limits of ordinary practice the fat percentage is not influenced as much by the physical condition at this time as is the milk yield. However, when the conditions are rather extreme, a pronounced effect upon the fat percentage results. A cow which calves in a decidedly fat condition, may for the first 20 to 30 days, have a fat test very much above her normal for the year and, likewise, decidedly more than would be found if she were in a thin condition. In some cases the effect may continue for as long as three months. The possibility of influencing the test in this manner is of the greatest importance in connection with the official testing of dairy cows. A further discussion will be found in that connection.

A single, rather extreme case will suffice to illustrate the possibilities. The writer, in conducting the original experiments establishing this factor, secured an average fat percentage for 7 days of 5.1 from a Holstein cow fattened to excess before calving. Her average for the year was 3.3. The following year the same cow, calving in moderate flesh, averaged 3.6 per cent of fat for 7 days while for the year the average was 3.3 or the same as the preceding year.

Influence of Œstrum. The question is often raised as to the suitability of milk produced during the period of heat or œstrum for human food, especially for infants or invalids. It is recognized that any unusual excitement or exercise may change the composition of the milk, especially in regard to fat content. However, the œstrum is a perfectly normal function of the animal and should hardly be classed as unnatural or abnormal, and it is doubtful if any harmful effect would be produced upon the milk.

The question has been studied by a number of investigators. The facts as brought out by a rather extensive investigation by Doane indicate that in some animals there is no effect upon the fat content of the milk while with others the reverse may be true. Two cows used in his experiments increased the fat content of the milk over one per cent while the other three showed no variation. The other constituents were not affected, and, so far as chemical analysis showed, the milk was practically normal and fit for consumption. It was recognized, however, that the possibility existed of some substances being present that might be detrimental, but which the chemical analysis would not reveal. Among the herdsmen in charge of cows on official test the opinion is commonly held that the fat test is increased during the period of œstrum.

Influence of Drugs. The interest in the possible use of drugs as a means of stimulating milk production arises largely in connection with the phenomenal milk and fat records which have characterized official testing in recent years. The assumption is sometimes made that those responsible for the care of cows producing such astonishing quantities of milk and fat resort to the use of drugs or some secret means of producing these records.

However, there is no evidence that it is possible to use drugs for this purpose. On the contrary, most of the experimental evidence available shows rather a depressing effect from drugs.

Hayes and Thomas reported experiments in using various drugs and tonics. The tonic was a mixture of oil meal, saltpeter, epsom salts, gentian, fenugreek, powdered charcoal and sulphur. They also fed air-slaked lime, Fowler's solution of arsenic and a tonic containing sulphide of antimony, sodium bicarbonate and ginger. The only significant increase in milk production followed the use of the air-slaked lime. Some of the drugs depressed milk secretion, and the others were without effect.

McCandlish concluded that drugs cannot be relied upon to give an increase in milk flow. He tried alcohol, castor oil, pituitrin, pilocarpine, aloes, and epsom salts—with negative results.

Relation between Daily and Yearly Production. The only means of knowing what a cow will produce in a year is to keep systematic records. It is recognized that an estimate of yearly production based upon the results of a few days is certain to have at best a limited value. As is often the case an average can be determined that will represent reasonably well the results from a group. Individuals, however, will vary widely from the average due to the many factors determining milk production. However, in a herd where uniform conditions of feeding and care are maintained, there is a fairly definite relation between the highest point of the lactation period and the total production, and figures showing this relation have some value.

Table 58 brings together data showing this relation as expressed in averages. The figures given by breeds are averages compiled from the records of 250 pure-bred cows, milked twice a day and freshening again within twelve months. These animals all received good feed and care. In compiling these data the individuals were placed in groups according to their average daily production for the month having the highest total milk during the lactation period. It will be noted that some irregularities appear in the rate of increase from group to group. These irregularities would largely disappear if figures were available for a group of sufficient size.

An examination of the data in detail showed that about 90 per cent of the total records for each group came within the figures given in the column indicating the probable yearly production. The table shows, for example, that a cow averaging between 25 and 30 pounds of milk daily at her best, should be expected to produce between 5,500 and 6,500 pounds for the year; a daily average, at the best, of 40 to 50 pounds indicates 8,500 to 9,700 for the year. The figures seem reasonably uniform for the four breeds included. It should be added that the animals supplying these data had excellent treatment, and the estimated yearly production in proportion to the daily yield is therefore rather high for many herds.

TABLE 58. RELATION OF DAILY MILK YIELD TO YEARLY PRODUCTION
TWICE-A-DAY MILKING, CALVING WITHIN TWELVE MONTHS

AVERAGE DAILY YIELD HIGHEST MONTH	AVERAGE YIELD FOR LACTATION PERIOD				PROBABLE YEARLY MILK PRODUCTION
	HOLSTEIN	AYRSHIRE	GUERNSEY	JERSEY	
LBS.	LBS.	LBS.	LBS.	LBS.	LBS.
15–20	3,787	3,985	3,914	3,600	3,000– 4,500
20–25	5,480	5,158	4,614	5,498	4,500– 5,500
25–30	6,864	5,577	5,996	6,172	5,500– 6,500
30–35	7,079	6,367	6,548	7,133	6,500– 7,500
35–40	7,880	6,913	8,052	8,010	7,500– 8,500
40–45	9,598	8,557	8,900	9,385	8,500– 9,700
45–50	10,190	10,800			9,700–11,000
50–55	11,435				11,000–12,000
55–60	12,693				12,000–13,000
60–65	13,118				13,000–14,000
65–70	14,851				14,000–15,000

TABLE 59. RELATION OF DAILY MILK YIELD TO YEARLY PRODUCTION (OFFICIAL TEST CONDITIONS)

AVERAGE DAILY YIELD HIGHEST MONTH	AVERAGE MILK YIELD			PROBABLE YEARLY MILK PRODUCTION
	HOLSTEIN	GUERNSEY	JERSEY	
LBS.	LBS.	LBS	LBS.	LBS.
20–25			6,112	6,000– 6,500
25–30		8,030	6,770	6,500– 8,000
30–35		9,394	8,800	8,000– 9,500
35–40	10,745	10,935	10,505	9,500–11,000
40–45	12,722	12,035	11,513	11,000–13,000
45–50	13,993	12,883	12,515	12,000–14,000
50–55	15,675	14,362	14,254	13,500–16,000
55–60	17,092	16,440	15,337	15,000–17,500
60–70	18,354	17,599		16,500–19,000
70–80	20,096			18,500–21,000
80–90	21,063			20,500–23,000
90–100	23,811			22,000–25,000
100+	28,821			24,000–29,000

Table 59 gives similar data based upon the official records of 350 pure-bred cows. The records were grouped according to the average milk yield for the highest month. The average milk yield of the groups for the year are given for comparison. The last column of the table gives the estimated yearly milk yield based upon the daily productions as given. Official test records are the results of a combination of a high-class cow and of expert care and management. For this reason they are subject to wide variations in the relation between daily production and the yield for the year. This is especially true in the groups showing the exceptionally high daily production. For these reasons the table should be looked upon as indicating the relation between daily and yearly production in a general way only, and too much accuracy should not be expected as applied to individuals.

Milk Production, Advanced Registry Testing Conditions

Compared to Ordinary. In recent years official testing of purebred dairy cows has become general and the records of milk and fat production are given wide publicity. Fifty years ago a production of 14 pounds of butter in a week, or 500 pounds in a year, was sufficient to justify a wide-spread reputation for a dairy cow. Now records over 30 pounds in seven days and 1,000 pounds in a year are too common to attract more than local interest. An important question arises in this connection as to what extent these greatly increased records of recent years are the result of better breeding and to what extent they are to be attributed to more skill in feeding and management.

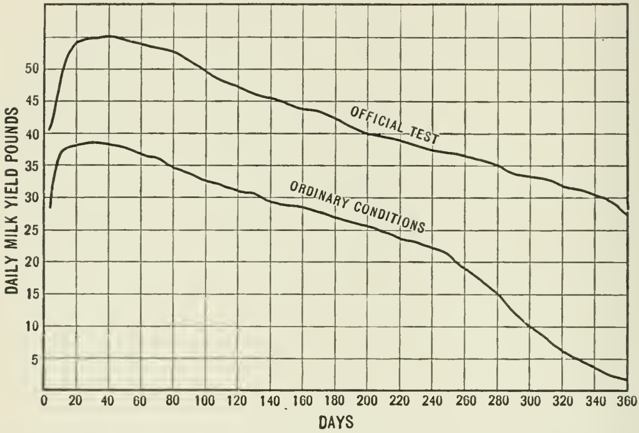


Fig. 72. Comparison of production under good farm conditions and official testing

This chart shows the average daily milk production during two years for a group of 41 cows, including four breeds. The curve marked "ordinary conditions" shows the production during the lactation period under good farm conditions, which includes twice-a-day milking, and freshening again within 12 months. The line "official test" represents the production of these same cows under official test conditions which includes three or four milkings daily, extra care and delayed breeding. The official test conditions gave an increase of 70 per cent in milk over good farm conditions.

Important questions also arise in connection with the records from the cow test associations and their relation to records from official test conditions. Cow test associations are becoming an important factor in the improvement of dairy cattle. The records of these associations, however, are decidedly below those made under conditions of advanced register testing. The question arises as to how far it is fair to compare them, and if the wide range in records between the two is due to the quality of the animals or to a difference in feed and management.

There is no question but that greatly increased milk and butter fat records in recent years are to be attributed in no small part to the results of intelligent breeding; the greater factor, however, is more skill in feeding and management. The cow under test for advanced registration is first of all prepared for the test by liberal feeding preceding the time of calving. While the test is under way she is milked three or four times daily, breeding is generally delayed, the best possible ration is provided, and she receives the most careful attention that a skilled herdsman can give. Under typical farming conditions, the milking is done twice daily, and the cow is expected to drop another calf within twelve months. The feed and care varies widely, but the cow at best receives far less attention than would be the case under official test conditions.

TABLE 60. COMPARISON OF RESULTS FROM COWS UNDER OFFICIAL TEST CONDITIONS AND ORDINARY CONDITIONS

BREED	NUMBER ANIMALS	OFFICIAL TEST CONDITIONS		ORDINARY CONDITIONS	
		MILK	FAT	MILK	FAT
		LBS.	LBS	LBS.	LBS.
Jerseys	17	10,213	531	6,554	331
Holsteins	18	18,928	618	10,456	366
Guernseys	3	12,197	552	6,983	328
Ayrshires	3	12,222	449	7,871	283
Average	41	14,331	564	8,395	343

The results of a study made by the author concerning the relation between milk production under official test conditions and ordinary conditions are given in Table 60. The data used are from the records of the Minnesota, Nebraska, Storrs, and Missouri experiment stations. Records were available for 41 cows that had been kept one year under typical conditions of official testing and another year in the same herd under good practical conditions, such as are usually followed on the best farms and which are typical of cows tested in cow test associations. These cows were milked twice a day and calved again by the end of twelve months. Table 60 shows that the cows under official test conditions average 70.7 per cent more milk and 64.9 per cent more fat than when milked twice a day and calving again within the year. The production under ordinary conditions, it should be noted, was excellent, indicating that cows that make good records under official test conditions are unquestionably superior animals and may be relied upon to give a liberal production under ordinary conditions. Taking these figures as representative, it is safe to expect the production of a cow under ordinary conditions to be about 58 per cent of her official test. These results suggest that at times there may be a tendency to overrate cows with official records in comparison with cows tested under cow test association conditions.

An analysis of the records reported in Table 60 shows that the difference between records made under official test conditions and ordinary conditions is greatest with those making the highest records under official test. The 41 animals were divided into two groups, those producing more than 600 pounds of fat and those producing less. The comparison is as follows:

	Number of Animals	On Official Test Average Fat Production	Under Ordinary Conditions Average Fat Production
		Lbs.	Lbs.
Above 600 lbs. Fat in Official Test	17	673	363
Below 600 lbs. Fat in Official Test	24	487	328

The percentage of increase in milk for the first group was 90.5 and for the second 52.9. These results are as should be anticipated. The situation is that the higher record cows have the greater capacity for milk production, and under conditions of official testing have opportunity to make use of all their capacity. Under ordinary conditions other factors set the limits and a cow that has the ability to produce 700 pounds of fat under the favorable conditions of official testing may not under ordinary conditions produce much more than one that is capable of making an official record of only 500 pounds of fat. The large records made under official test conditions are the result of a cow with outstanding ability as a milk producer combined with the most favorable environment.

Influence of Age upon Richness of Milk. A large amount of data are available on this point and the facts are well established.

Table 61 gives a compilation of data including all official testing records. These figures are especially valuable on account of the very large number included—over ten thousand for one breed alone. These data show no variation in fat percentage of any consequence due to age, within the limits usually included by cows on official test.

Table 61. Relation of Age to Fat Percentage (Results from Official Tests)

Age	Holstein	Ayrshire	Guernsey	Jersey	Brown Swiss
Years	Per cent	Per cent	Per cent	Per cent	Per cent
Over 5	3.42	3.91	5.00	5.27	3.93
4–5	3.39	3.95	4.01	5.36	4.02
3–4	3.39	4.00	5.04	5.45	4.06
2–3	3.42	4.05	4.98	5.37	4.01

Table 62 gives the results of a compilation from the records of 41 Holsteins and 74 Jersey cows kept under good conditions but not under official test. These data show the same facts as illustrated by the previous table except that the records are extended to older animals. The records are for lactation periods and cannot be translated into age with accuracy. As a rule the cows supplying these records calved at the age of 26 to 28 months and the intervals between freshenings average a little more than a year.

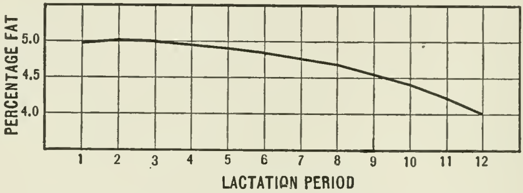


FIG. 73. Influence of age upon richness of milk

The chart shows graphically the data from the Jersey breed in Table 62. The age of the cow has practically no effect upon the richness of her milk during the limits of age usually represented by cows in commercial herds. After the age of ten or twelve years a gradual decline occurs from year to year. A Jersey cow testing 5.0 per cent of fat when young, if she continues to milk to the age of fifteen years, will test about 4.0 per cent.

The figures show that the richness of the milk remains practically constant, fluctuating slightly with individuals from year to year until the animal is past her prime, when it slowly declines with advancing age. A cow of a high-testing breed averaging 5 per cent of fat as a young animal will decline to about 4.5 per cent if she continues to produce to 14 years of age.

A heifer having a low test as a two-year-old is sometimes excused on the ground that she is young and will do better when mature. The data show there is no ground for such belief. The facts are that the richness of the milk is a matter of inheritance and is fixed even before the animal is born. Nothing can be done to change it. Selection of the breed of breeding stock from high-testing families and of individuals are the means to be used in securing a high-testing herd.

Table 62. Relation of Age to Fat Percentage (Records from Cows under Ordinary Conditions)

Lactation Period	Jerseys	Holsteins
	Per cent	Per cent
1	4.99	3.30
2	5.04	3.23
3	5.00	3.24
4	4.89	3.29
5	4.97	3.19
6	4.85	3.34
7	4.76	3.18
8	4.63	3.21
9	4.54	3.16
10	4.40	3.10
11	4.22	
12	4.00	

CHAPTER XXIV

COMMON AILMENTS OF CATTLE

This book makes no pretense of giving directions for the treatment of such accidents and diseases as call for the services of the competent veterinarian. A brief discussion is made of the most common ailments of cattle that the cow owner should undertake to treat without extensive experience. The discussion of tuberculosis and contagious abortion is in the nature of advice for the owner of dairy stock, and is not expected to take the place of expert advice by the veterinarian.

Instruments and Medicine Needed. Every manager of a herd of dairy cattle should be prepared for the ordinary emergencies that are certain to come. If a competent veterinarian is not readily accessible, such preparedness is all the more important. The following instruments are the most often needed, and it is advisable to have them on hand:

Milk fever outfit
2 milk tubes of different sizes
3 teat plugs of different sizes
Trocar
Syringe
Drenching bottle
Clinical thermometer

For those with some experience a surgeon's scalpel should be added.

A liberal amount of a good disinfectant should always be on hand, because almost constant use will be found for it. For this purpose some of the common coal tar preparations are suitable, or crude carbolic acid, which can be prepared in a 2 per cent solution to be applied to the animal's body or in a 5 per cent solution to disinfect other objects, such as the floor of the barn or instruments. Tincture of iodine is indispensable for disinfecting wounds and treating the navels of new-born calves. An abundant supply of epsom salts should also be on hand, as occasion for using it will come often. In most herds entirely too little use is made of this important medicine. A dose of 1 to 1½ pounds of salts for the grown animal should be the first treatment in nearly all cases of sickness. In every case when an animal shows loss of appetite or sickness the cause of which is not known, a physic should be given at once and the feed reduced. A second dose after three or four days is often beneficial. If the appetite of the animal has returned, the ration can again be increased to the normal.

Drenching a Cow. The common method of administering medicine to a cow is to mix with water and give from a bottle. This is known as a "drench." When giving a drench, the head of the animal should be elevated by being tied or held by an assistant. The operator stands on the left side, and grasps the nose with the thumb and fingers in the nostrils. The bottle used should be adapted for the purpose: having a long, strong neck such as a wine bottle. The mouth of the bottle should be inserted in front of the back teeth and rest on the cow's tongue as far back as the middle of the tongue. If the animal coughs, the head should be at once lowered to allow the liquid to escape from the wind pipe. If this is not done, the medicine may pass down into the lungs, and cause pneumonia. Unless there is come special reason for doing so, it is not customary to give over 1 to 2 quarts at a time. Unless the herdsman is thoroughly informed regarding the treatment of cattle ailments, he will seldom have occasion to administer medicine other than epsom or Glauber salts except under the direction of a veterinarian.

Tuberculosis. This insidious disease is of the greatest importance to dairy cattle owners as well as to milk consumers. Its ravages in the dairy herds result in tremendous financial losses each year, and the use of milk from diseased cow is a menace to the health of the milk-consuming public, because a considerable percentage of tuberculosis in the human family—especially among children—is due to the consumption of dairy products from tuberculous cows. This disease has been the subject of great concern on the part of health authorities, and much thought and study have been devoted to perfecting means for its control and eradication inasmuch as no cure has yet been found.

The direct cause of tuberculosis is a rod-shaped germ, not visible to the naked eye but readily seen under a high-power microscope. It cannot develop in an animal from methods of handling or from the surroundings, but it must be communicated in some way from one animal to another. It is not inherited. Outside the bodies of animals the germs are incapable of reproducing themselves, but they may live a long time when crusted over with dried manure, or when in places not exposed to the direct rays of the sun.

While it is true that the germs of tuberculosis must be introduced into the body of the animal before the disease can develop, there are certain conditions which render animals more susceptible to the attacks of the disease. Animals which are poorly nourished, or housed in filthy, dark quarters without proper ventilation or facilities for exercise, or those which have been subjected to a severe physical tax such as prolonged heavy lactation, have all had their vitality lowered and consequently have less power to resist the invasion of the disease organism.

How the disease spreads. The presence of one diseased animal in a herd at once becomes a menace to the health of all. It is impossible to determine just when a tuberculous cow becomes a "spreader," but sooner or later she begins to give off the germs of the disease. They escape with the slobber from the mouth, in the exhalations from the nose, with the dung—and, in badly affected animals, with the milk. If the disease is accompanied by coughing, the germs are sprayed over quite an extensive area in the minute droplets of moisture discharged by the act of coughing. In this manner animals in adjoining stalls may take in the germs by inhalation, or by eating feed which has been contaminated. Common watering troughs, ponds and drinking holes are also thoroughly contaminated by the discharges of diseased cattle, and serve to spread the infection. Another means of disseminating the disease is by feeding milk from tuberculous cows to young animals without first pasteurizing it. This may easily occur when milk is brought back from the creamery and used for calf feeding. Safeguards against this danger have been given fully in the chapter on calf feeding. Hogs following tuberculous cattle are readily affected from the manure. If a diseased animal is placed in a healthy herd, other cases are sure to follow soon. It is believed now by the best authorities that the most dangerous animal from the standpoint of human health is often the one that may appear perfectly healthy, but which passes the germs of the disease with the manure. From this source some of the germs may find their way into the milk, making it possible for the milk to be infected even though no germs come through the udder.

How it affects the animal. Tuberculosis in a cow may run its course quickly, resulting in the death of the animal, but this seldom occurs. As a rule, it progresses slowly and the animal may have it for years without any indication of ill health. All this time the animal is a menace to the health of the people. The disease may attack any part of the animal's body, but is most common, as with persons, in the lungs and lymph glands. In advanced stages the disease becomes generalized; lesions are present in the lungs, liver, spleen, and lymph glands, and clusters of tubercles frequently form on the membranes lining the chest cavity. The udder is also invaded by the organisms, and open lesions in this organ are sure to result in the presence of large numbers of tuberculosis germs in the milk, It should be thoroughly understood that it is impossible to judge from external appearances, except in extreme cases, whether the animal is affected or not. Neither can any examination of the milk that can be made be depended upon as a reliable test of the presence of the disease. Fortunately we have in the substance known as tuberculin an almost infallible agent for determining the presence of the disease even in the smallest degree. Before many years it will unquestionably be required by law that every cow supplying milk for human food be tested with tuberculin and found free from tuberculosis, as is now done by some cities. Even leaving the question of human health out of consideration, the dairy cow owner should have his animals tested and keep his herd free from this disease for pecuniary reasons.

The tuberculin test. The tuberculin test is now considered to be the most practicable and satisfactory way of discovering the disease in living animals. The test consists of introducing tuberculin into the animal and interpreting the results according to well-known standards. Tuberculin is a laboratory product, scientifically prepared, and contains no living tubercle bacilli. No harm can result to healthy animals when it is applied even in much larger quantities than are employed in making the tests. The use of tuberculin should be limited to experts trained for this work, as the successful employment of the test depends on the accurate interpretation of the results, and this can only be done by thorough training.

There are three standard methods of applying the test for tuberculosis in cattle. The *subcutaneous* test is perhaps most frequently used, and by this method the tuberculin is injected beneath the skin. If an animal has the disease, the injection of the tuberculin causes a fever, which is indicated by a rise in temperature—ordinarily at any time between the eighth and twentieth hours after the tuberculin is injected. Three preliminary temperatures are taken before injection, at intervals of two hours, to determine if the animal is in condition to test. The post-injection temperatures are also taken at intervals of two hours, beginning usually the eighth hour after injection. Interpretation of the results are made according to a certain standard. The application of the subcutaneous test requires considerable time, and the almost constant presence of the person applying the test until all temperature readings have been made. It also necessitates keeping the cattle tied up in order that the readings can be made without delay.

The *intradermal test* is applied by injecting only a few drops of the tuberculin between the layers of the skin—usually in the region at the base of the tail. A proper interpretation of the results of this test requires more skill than in the case of the subcutaneous test. A positive reaction consists of a swelling at the point of injection and is observed from 48 to 108 hours after injection of the tuberculin. The swelling may vary in size from that of a pea to that of a walnut, but the magnitude of the swelling has no direct relation to the extent of the disease. This method of testing is used most in range herds, where the animals cannot all be tied up, It can be applied to a greater number of animals in a given time, and does not require the constant attention called for in taking periodic temperatures.

The third method is known as the *ophthalmic test*. Tuberculin is applied to one eye, resulting in a characteristic inflammation and sometimes pus formation. This test is never used alone, but is quite often employed as a check test for either of the foregoing methods.

The question is often raised as to the accuracy of the tuberculin test. It has been thoroughly demonstrated that it seldom if ever fails in the hands of a person who thoroughly understands its use and the interpretation of the results secured. The only means at present for determining the correctness of its diagnosis is the post mortem examination of condemned animals. These examinations are conducted in a sufficiently large number of cases to prove that close to 100 per cent of the animals condemned show lesions of the disease somewhere in their bodies. No attempt is made to carry out microscopic examinations, and it is possible that in most cases reported where no visible lesions were present, the disease was in its incipient stages and its progress was so slight as to escape detection by the ordinary methods employed.

It is true that occasionally an animal affected with tuberculosis fails to react to carefully applied tests and escapes condemnation. The consequence is that she remains in the herd and may be the means of disseminating the disease and causing a serious outbreak when she becomes a spreader. Fortunately this occurs only in a very negligible number of cases and cannot be used as an argument against the value of the test. The cause for this failure of certain animals to react cannot be explained at present.

The accredited-herd plan. The accredited-herd plan was originated in order to afford to those breeders with tuberculosis-free herds the benefits to which they are entitled by reason of their freedom from the disease. The work is conducted under the direction of the United States Department of Agriculture. Herds which are found to be free from tuberculosis on two successive annual tests are placed on the Honor Roll, and a certificate is given to the owner by the State and the Federal Government. This certificate entitles the owner to ship animals of his herd interstate without additional tuberculin test for the period of one year. At the expiration of one year the herd is again tested, and if no reactors are found a new certificate is issued for the ensuing year. The breeder of pure-bred stock who can guarantee his animals to be free from tuberculosis finds it a valuable recommendation. When new animals are introduced into a tested herd, they should be only those coming from similar herds, or else should be held in quarantine until they have been carefully tested and pronounced healthy. In this way the introduction of the disease from the outside is effectually checked. However, yearly retests are a necessary safeguard, and of course must be maintained by the herd which continues in the accredited-herd list.

At the present time the area plan of eradication is being adopted, and entire districts are having all cattle tested and reactors eliminated. Great benefit will follow the wider use of this method, as it does away with the danger of infection from adjoining farms, and also increases the value of all livestock in the tested area.

It is worth while to observe the progress made by the accredited-herd plan recently, as indicated by the following figures: On June 30, 1920 there were 3,370 fully accredited herds and 16,599 once-tested free herds. On January 1, 1922, there were 11,587 fully accredited herds consisting of 267,411 cattle; 96,644 once-tested free herds comprising 1,051,278 cattle; and, under state and federal supervision, 133,481 herds containing 1,871,664 cattle.

The best means of dealing with the tuberculosis scourge are: To apply the tuberculin test until the herd is free from all reactors; avoid the purchase of animals except from accredited herds, or insist upon a retest after the animals are shipped; and be sure that animals are not exposed to the disease while in transit, by thoroughly disinfecting all cars in which healthy stock is loaded, and keeping them away from stock pens if possible.

Abortion. This term is used by cattlemen to indicate the expulsion of the fetus at any time before completion of pregnancy. Abortion may be contagious or non-contagious. The non-contagious cases may occur as the result of injury—as from falling or being kicked by a horse or being crowded in a doorway. Poor feed, especially that deficient in protein or mineral matter, sudden change of feed, and severe cases of indigestion, such as bloating, may also be the cause. It is also known that ergot may cause widespread abortion in cows. This fungus is seen as black, hard, spurlike growths which protrude from the seeds of grasses at the time of ripening. Rye grass is especially subject to ergot, and ergot is common in blue grass, especially in low wet places.

When a single case of abortion occurs in a herd, it is to be attributed to some accidental cause; but it should be regarded with suspicion, and close watch kept on all females approaching parturition. If a number occur near together, the cause may occasionally be looked for in ergot in the feed. As a rule it is due to the presence of the contagious disease.

Contagious or infectious abortion. The financial loss incurred by dairymen through the ravages of this disease are believed to be even greater than those caused by tuberculosis. In consequence, much painstaking experimental work is now in progress to increase the existing fund of knowledge regarding its nature and the means of its spread, and to develop methods of control. The premature expulsion of the fetus is merely one of the evidences of the presence of the disease, but failure to abort is no indication that a cow or heifer is free from the germs which are responsible for the abortion disease. All animals affected with tuberculosis bacilli do not die from its effects, and similarly the presence of the abortion germ does not induce abortion in all cows. The tremendous losses due to the ravages of this disease are not confined to the calves which are expelled prematurely but its greatest destruction is wrought by the after effects of the action of the disease organisms on the generative organs of infected animals. One common sequel of infectious abortion is the retention of the fetal membranes or afterbirth, portions of which may remain in the uterus and decompose. In this condition the uterus is open to invasion by other destructive bacteria, and the infections which they bring about often result in permanent inflammation of the membranes of the uterus, chronic enlargement of the cervix or neck of the uterus, cystic de-generation of the ovaries, and diseases of the Fallopian tubes which convey the eggs from the ovaries to the uterus. All of these conditions are prone to interrupt the normal reproductive processes and result in permanent sterility, which means the loss of valuable animals from the herd in addition to the initial loss of the calves.

The cause of abortion disease. The usual cause of bovine infectious abortion is a germ discovered by Prof. Bang, of Denmark, in 1896, and known as the *Bacterium abortus* of Bang, or Bang's Bacterium. It is generally believed that the common bacteria causing the trouble, the *Bacterium abortus*, are taken into the digestive tract through the mouth of the mother, and reach the uterus by means of the circulation. Recent investigations show that at times other species of bacteria are the active agents. The bacteria attack the membranes which surround the fetus and cause a separation of the fetal and maternal membranes, thereby cutting off the food supply of the fetus and resulting in its premature expulsion from the uterus. Without proper care of the mother at this time by a competent person the after effects already listed are likely to occur.

The abortion bacterium resides in the placentas of aborting cows, in different portions of the body of the aborted fetus, and in the udders and associated lymph glands of affected cows. It occasionally attacks and can be found in the reproductive organs and seminal fluid of bulls. It is present in the uterus only a short time before the act of abortion or parturition, and rarely persists in that organ for a longer period than three weeks or thirty days after an abortion. It may persist in the udders of aborting cows for several years without causing further trouble.

The presence of the abortion germ in the body of an animal may be definitely determined by the application of a blood test. A positive test is no indication that the animal will abort, but such an animal should be regarded with suspicion and is capable of spreading the infection to other members of the herd even though she herself carry her calf full time and deliver a healthy calf. The germs are undoubtedly present in the uterus at the time of parturition, and the fetal membranes and fluids and all discharges from the uterus are thickly seeded with virulent bacteria. Other cows coming in contact with such an animal shortly before or after she calves are apt to ingest some of the discharges, either by licking her or by consuming feed or bedding which has been soiled by these discharges. The principal danger of spread of disease is from the aborting cow or infected cow at time of calving, by the careless handling of the afterbirth and the failure to keep her isolated during that period before and after aborting or calving, when she is giving off active germs from the vagina. Newly born calves from infected cows should be handled so they have no opportunity to soil the feed or bedding used for the rest of the herd. All bedding from the maternity stalls is classed as infected material. The bull may act as a spreader if he is used to breed cows before the infection of the uterus has been cleaned up; or if his genital organs are diseased and the germs given off in the seminal fluid. The infection occurs by the dripping of mucus or fluids from the vaginas of cows after breeding. Another possible source of spread is the milk from cows harboring the germs in their udders. They are present in the milk drawn from such cows and may be fed to calves in this manner, or may be introduced to udders of other cows on the hands of a careless milker. However, this is considered only a remote possibility as a means of disseminating the disease. In brief, the paramount danger lies in the aborting and positive cows and with them the critical period is at or near the time of abortion or calving.

Treatment and prevention. No specific cure for infectious abortion has yet been found, and the use of vaccines and serums to combat the disease is still in the experimental stage. We may hope for relief along this line if some of the preliminary results are borne out by more extensive trials, but at present the work to combat the disease under ordinary herd conditions should be directed toward the prevention of its entrance into healthy herds, and its control, when the disease has made an entry, by means of isolation and sanitation according to rules laid down by leading students of the subject.

The following recommendations for the prevention of the entry of contagious abortion into healthy herds, and its control where present, are worthy of serious consideration:

Breed and raise your own animals in so far as possible, to avoid the introduction of disease with purchased animals. In buying an aged bull or pregnant cows the greatest care should be exercised to make certain that the disease is not prevalent in the herd from which the animals are bought. Insist upon a blood test before introducing an aged bull. Unbred heifers and bull calves may be brought in with slight risk. Isolate pregnant cows until they have dropped their calves.

If a blood test is made on the entire herd, regard all positive cows with suspicion and watch them carefully before calving time. Otherwise handle all cows as though infected if any abortion has occurred in the herd.

Since aborting cows and cows infected at parturition are discharging the germs in large quantities, it is essential that they be isolated. This is best accomplished by keeping them in individual maternity stalls, preferably in a building separate from the main cow barn. The stalls should be isolated from one another. Aborters and infected cows should be kept isolated until all discharges from the vagina have ceased. The maternity stall should always be thoroughly cleaned and disinfected when a cow is removed and another installed.

When an abortion occurs, the animal should be treated by a competent veterinarian to avoid development of complications which may result in permanent sterility.

The principal avenue of infection is through the mouth, and to avoid the spread of the disease all feed and bedding should be handled so as to prevent contamination by the discharges from diseased cows, new-born calves, or milk from infected cows. All bedding from maternity stalls, the afterbirth, and all material containing discharges from aborting cows should be disposed of in such a manner that none of the other animals will have access to it. If the abortion occurs in pasture, the ground should be covered with lime at the place where the calf was dropped.

Breed normal females only, and if there is any suspicion regarding the condition of the bull, breed on neutral ground and isolate the cow after breeding to prevent spread of infection by mucus or seminal fluid which may drip from the vagina.

Keep close watch on the females in the herd for signs of abortion, which are quite similar to those in evidence at the time of normal calving.

Do not sell animals which have aborted, as such individuals ordinarily acquire immunity and are less susceptible to the disease than new cattle which might be introduced by purchase. Watch them closely after they are again safely in calf.

Build up the resistance of the herd to all disease by feeding properly balanced rations containing a sufficient quantity of essential mineral elements.

Treatment by means of uterine douching should be undertaken only on the advice and under the direction of a veterinarian.

Douching the bull before and after service is a practice frequently recommended, but where care is taken to breed cows only after all discharges have ceased and their generative organs are normal, it would seem unnecessary to take this extra precaution. This matter is one on which investigators are not in full accord.

Udder Troubles. One of the most common troubles with dairy cows, especially among highly developed milk producers, is inflammation of the udder. It varies in severity from a mild case, when the milk is slightly stringy for a few days or a slight swelling is found in the udder, to severe cases, where the udder becomes so swollen that no milk can be drawn, and which may end with the permanent loss of the udder.

Congestion of the udder. As a rule with heavy milkers, the udder is enlarged and more or less hot and tender just after calving. This swelling may extend forward to some extent on the abdomen; but it is to be expected and need not cause any anxiety. It is more pronounced when the animal has been well fed and is in good flesh. When such condition exists, the animal should not receive much grain until the udder softens. The ration should be laxative in nature, and of a light character. Bran is especially adapted for feeding at this time. The milk should be drawn several times during the day, the udder actively rubbed or kneaded afterward. Until the swelling leaves the udder the cow should be kept from exposure to cold weather and to cold drafts, and off cold, wet floors.

Inflammation of the udder. This common trouble is also known an mammitis, or garget. It varies greatly in severity. Many times the symptoms observed are swellings in the udder that do not even interfere with the milk secretion beyond causing a tenderness of the udder for a few days. Or the milk may be lumpy and full of threads, with no noticeable hardness in the udder. The milker should observe the condition of every cow carefully when milking, and report to the herdsman at once any abnormal condition noticed, or take any other action as seems necessary. Prompt action is always advisable lest the conditions become severe. Such light attacks probably come from a variety of causes. Any condition of the animal that lessens the power of resistance makes it possible for the trouble to start. Such a condition of the animal may be brought about by exposure to severe weather, lying with the udder on a cold floor, from injury to the udder by bruises, or by improper or too heavy grain feeding. In many cases, however, no special cause can be assigned. Mild cases, as above described, usually respond to treatment if taken in time. The grain ration should always be reduced to one third the usual amount or less at once when any inflammation appears, and kept there until the condition disappears. A physic should also be given at once, and care taken not to expose the cow to cold weather or cold drafts. An ounce of saltpeter per day for two or three days is generally beneficial after the purgative has begun to work. The cow should be milked with great gentleness, and preferably three or four times per day. If the udder is extremely sensitive, a milking tube should be used for a few days. Hot fomentations applied from 15 to 30 minutes three or four times a day usually bring relief.

Severe cases of inflammation. Occasionally severe attacks come on, and usually suddenly. These most often affect heavy milkers. The first symptom is a shivering of the animal, with cold ears and horns, followed in a short time by a fever. One or more quarters of the udder swell and become very hard, which is most often the first symptom seen, while the whole gland is decidedly hot and tender, and no milk can be drawn. Usually a small amount of yellowish watery fluid containing clots of casein replaces the milk. If the inflammation cannot be reduced within a short time, that quarter of the udder will not secrete any milk during that milking period, and perhaps will be permanently lost. In some cases the quarter will again secrete milk; in others, a fibrous mass may develop following such an attack, or an abscess result which fills the udder with pus and finally discharges either through the teat or through an opening in the side of the udder.

Treatment of such severe cases must be prompt and thorough, or permanent injury, as described, will result. The cow suffers great pain from the weight of the udder. A special udder support should be on hand, or a sheet passed around the body to support the weight of the udder. Under this support, next to the udder, may be packed soft rags, which are kept as hot as the animal will endure by pouring on hot water every few minutes for an hour or two. At the end of this time the udder may be dried and thoroughly rubbed and massaged for some time with a mixture of ten parts olive oil and one part therapogen. At this stage an application of antiphlogistine can be made to advantage. This material is warmed until soft by placing the can in warm water. It is then applied in a layer about one-fourth inch thick, with the teats protruding so that the milk may be drawn. A layer of cotton is then applied over the antiphlogistine, and the udder support put in place. In about twenty-four hours the material loosens and may be removed. If the inflammation is still present, a second application should be made.

Some veterinarians pack the udder in ice, which is replenished as fast as it melts and allowed to remain several hours. In the beginning of any treatment for a severe attack of inflammation of the udder a drench should be given containing 1 to 1½ pounds of epsom salts. One ounce of saltpeter (potassium nitrate) is also given to stimulate the action of the kidneys, and may be continued for several days.

Severe attacks of mammitis or garget as described above are due to the action of a group of organisms, and can, therefore, be readily transmitted from one animal to another through carelessness on the part of the milker, or by allowing the milk from an infected cow to run on the floor or gutters and later reach the udders of healthy cows. Animals showing signs of garget should be kept by themselves and milked last to avoid spreading the disease.

Milk Fever. Until recent years the owner of high-producing cows always had to face the danger of losing the most valuable cows by this common and usually fatal disease. One of the most important discoveries of recent years for the dairy cow owner is the discovery of the air treatment, which is so simple anyone of intelligence can apply it, and with almost certain success.

Milk fever occurs only with high-producing dairy cows. It rarely occurs with the first calf of a heifer, and seldom with the second. It affects mature cows, and especially the heaviest milkers. The well-nourished cow is more subject to it than the underfed, which was the reason for the practice—common before the present treatment was discovered—of withholding feed for several days before parturition. The great advance made in recent years in the records of milk production is to be attributed to a considerable extent to the air treatment which makes it possible to have cows in a high state of flesh at calving without loss from milk fever.

The disease is so typical as to be easily recognized. It occurs in nearly every case within 48 hours after calving, and usually only after normal parturition. Every cow likely to be affected should be watched carefully for symptoms until the danger is past. The first indications are restlessness and excitement on the part of the cow. Within a short time paralysis of the hind legs begins, resulting in a staggering gait. The animal soon falls and is unable to rise. From this time on the cow becomes unconscious, and remains so until death occurs in from 18 to 48 hours unless treated. The cow assumes a characteristic position, which is of great value in diagnosing the case. The head is turned to one side, and rests on the chest with the muzzle pointing toward the flank. The entire body is paralyzed, making it impossible to give medicine; but fortunately none is required.

The first effective treatment was discovered by Schmidt of Denmark, who injected a solution of iodide of potash into the udder. Later Anderson, also of Denmark, found that the injection of ordinary air is far superior to the first treatment. This is the method now universally used. Every dairyman should be provided with a suitable milk fever outfit to treat cases as promptly as they appear. The apparatus used may be of various forms. The most approved is shown in Fig. 74. The essential parts are a milk tube, to which is attached a rubber tube, a receptacle of some kind in which clean cotton is placed to catch the dust in the air as it is pumped through it, and a rubber bulb or a pump of some kind. In case an approved form of apparatus cannot be secured, an apparatus can be improvised that will serve the purpose. The author has known cases where a common bicycle pump with a quill for a milk tube was used to save the life of a cow where no better appliances could be had.

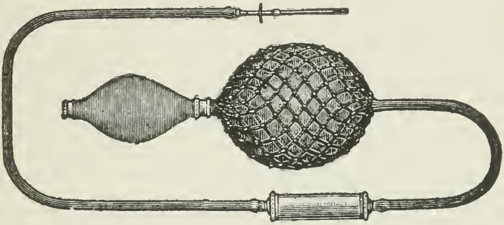


Fig. 74. Apparatus for treating milk fever

Every herdsman responsible for a valuable dairy herd should have a suitable milk fever outfit at hand ready for use

However, while it is possible to stop the milk fever by any means that makes it possible to pump the udder full of air, there is great danger of introducing infection at the same time that will cause inflammation and possibly result in the loss of the cow's udder.

Use of the apparatus. In using the milk fever apparatus the operator should first thoroughly clean his hands—likewise the cow's udder and teats—with warm water and soap, followed by a 5 per cent solution of carbolic acid or creolin. That portion of the apparatus which holds the cotton, and the rubber tube leading to the milk tube—likewise the latter—must be clean, and preferably boiled 15 minutes before using, then disinfected by the use of the carbolic acid or creolin. The receptacle for holding the cotton is filled with ordinary cotton, or, better still, absorbent cotton, which may be purchased from most drug stores. The milk tube is then inserted into one of the teat openings without drawing what milk is contained, and air is pumped through the cotton into the udder. This is continued until the quarter is well distended with air, when the tube is carefully withdrawn and a tape tied around the teat tight enough to prevent the escape of the air. The same treatment is applied to each quarter. The teats are allowed to remain tied. Ordinarily within two or three hours the cow will regain consciousness and be able to stand on her feet. If the air is absorbed or escapes, so the udder is not tightly distended, the tape should be removed and another injection of air made as before. Usually two injections are all that is required. The udder should remain full of air 24 hours at least, and longer if any sign of the trouble remains. The calf of course is not allowed to suck during this time. If inflammation of the udder follows, it indicates insufficient care in disinfecting the apparatus used.

No attempt should be made to drench a cow suffering from milk fever, as her throat is paralyzed and any liquid introduced into the mouth will enter the lungs and cause pneumonia.

Lice. During the winter season especially, cattle are often affected with lice. Calves and young cattle are most often affected, but older cattle are not exempt, and when in an unthrifty condition they may suffer from this pest. There are three kinds of lice that affect cattle. The species generally known as the blue louse, which sucks the blood, and is the most common and most injurious, is found most numerous upon the neck and shoulders. The eggs are attached to the hair, and are known as nits. The red louse, which is less common, may be found on any part of the body, but most numerous on the neck and at the root of the tail.

The presence of lice may be suspected from the cow's rubbing of the neck and shoulders on trees, posts, etc., and when the cow is badly infected the hair usually begins to come out in spots. Several substances may be used to kill the lice. The several coal tar dips and compounds on the market may be employed with success. The most satisfactory treatment will be found to be the use of kerosene emulsion. To make this emulsion dissolve one-half pound of hard soap in one gallon of boiling soft water. As soon as the soap is dissolved, add two gallons of kerosene, mix by pumping with a spray pump or by other means until a thick creamy emulsion is formed from which the oil does not readily separate. Before use, add this mixture to 19 gallons of water. The emulsion may be applied with a spray pump or with a brush. The application of raw linseed oil at the points affected and along the spinal column helps to control lice. Ground sabadillo seed dusted on the cows is also recommended for killing lice, and can be used when the weather is too severe for liquid application.

Pink Eye. This is a contagious inflammation of the eyes, common in many herds. It usually occurs during the latter part of the summer. It is known by a discharge from the eyes, accompanied by an intense inflammation of the mucous membrane. The eyelids swell, and the eye becomes opaque. The eyes are kept shut, and the animal is often blind for several days. In some cases the animal soon recovers without injury, while in others loss of the eyesight may result if proper treatment is not given.

The affected animal should be kept in a dark, cool stable and supplied with easily digested food and plenty of water. The eyes should be washed twice daily at least with a strong solution of boracic acid (1 dram dissolved in 4 ounces of water). This wash should be applied directly to the eyeballs, and can conveniently be done by the use of a syringe. The animal will usually recover within a few days.

Foot Rot. This is the name applied to a common inflammation that occurs between the toes and may extend above the hoof. It is attributed to the irritation caused by stable manure. or by some foreign substance such as a stone or cinder, wedged between the toes. It commonly affects sheep and cattle.

Animals running in stony lots or pastures become affected with foot rot quite often. It occurs, however, at times under conditions that leave no doubt that it is contagious. It is recognized by a limping gait and a swelling above and between the claws. The odor of the affected part is very offensive. If neglected, a serious condition may develop; but if treatment is given during the early stages, it is easily remedied. The most simple method of treatment is to trim away all diseased tissue, cleanse the parts thoroughly, and then apply some good disinfectant to the affected parts. Several applications of some of the coal tar disinfectants are usually sufficient to heal it. These are best applied in their pure form. A solution of carbolic acid, 1 ounce to a pint of water, or a saturated solution of blue vitriol (copper sulphate) will also give good results.

Bloat. This trouble comes from the formation of an excessive amount of gas in the paunch. It often results from pasturing on clover, but may occur with any kind of feeding. It is indicated by the excessive swelling of the left flank. If relief is not obtained in time, the animal dies from suffocation due to the great pressure on the lungs. In mild cases driving the animal at a rapid gait for some distance may be sufficient.

The formaline treatment recommended by Healy and Nutter has given especially good results. This treatment consists in giving the affected cow a quart of a one and a half per cent solution of formaline in the form of a drench. A round stick is tied in the mouth to keep the jaws apart. One-half ounce of formaline in a quart of water gives a solution of the proper strength. Relief is sometimes secured by administering three to four ounces of kerosene in the form of a drench followed by the use of the wooden bit.

In very severe cases the gas must be removed without delay. This is best done by the use of a trocar. In using this instrument a spot is selected equally distant from the last rib, the hip bone and the backbone. The skin is cut for about an inch, then the trocar is thrust into the paunch. The sheath of the trocar is allowed to remain in the opening as long as any gas escapes, which may be several hours. It is generally advisable to give a dose of 1 to 1½ pounds of salts after a case of bloating.

Impaction. Constipation or obstruction of the bowels is generally due to improper feeding. It is usually associated with all feverish conditions, and can ordinarily be prevented by avoiding excessive use of dry and bulky feeds, and by introducing more laxative and soft feeds in the ration. The condition of the feces is an early symptom of constipation, and the immediate administration of a physic when the feces appear unusually dry and in pellet form will ordinarily correct the condition. Impaction may be due to a twist or knot in the small intestine, induced by unusually violent exercise or sudden movements. In this case there appears to be no cure unless an incision into the abdomen is made and the knot or kink removed. When constipation has gone unnoticed for some time, and the animal is in a feverish condition, warm injections into the rectum may help the action of a physic; but it would be well in such a case to consult a veterinarian.

Actinomycosis (Lumpy Jaw). This disease in characterized by a swelling on the lower jaw, which may finally open and discharge pus. It is due to the growth of a fungus, which is introduced through injury to the mucous membranes lining the mouth, thus permitting the organism to attack the tissues. If neglected the swelling increases in size and the disease finally attacks the bone of the jaw. If treatment is given in the early stages, while the disease is confined to the soft tissues, complete recovery usually follows the opening of the tumors, removal of the diseased tissues, and treatment with blue vitriol or iodine solution. This treatment is best undertaken by one trained in the work.

Cowpox. This disease is usually ushered in by a slight fever, and is easily communicated by the hands of the milker from cow to cow. It attacks the udder and teats, and is characterized by eruptions which are small at first, but increase in size and finally form into a blister with raised margins and a depression in the center. If unbroken these blisters finally dry up and drop off as scabs. Cowpox ordinarily spreads to all members of the milking herd, but frequent washings with hyposulphate of soda solution may help to prevent the spread and check the inflammation.

CHAPTER XXV

FEEDING FOR MILK PRODUCTION

The economical production of milk depends largely upon two general factors. The first is the efficiency of the cow used. The efficient cow is the result of inheritance, and an animal with the desired characteristics is to be obtained by selection and breeding. The second factor controlling milk production is feed and care. Proper attention to the selection of the individual animal and to breeding merely insures that an efficient machine will be available for milk production.

The inherited ability of the cow to produce milk and the skill with which she is fed and managed contribute about equally to the final result. Where dairy cows are kept under approved conditions about one-half the total expense is for feed; the remainder represents labor, depreciation, housing, interest, and other miscellaneous items. The labor and other items mentioned are practically the same regardless of the total milk production. It takes nearly as much work to care for a cow giving 4,000 pounds of milk as it does for one producing 8,000 pounds. These expenses outside of feed, generally spoken of as the overhead expense, represent about one-half the cost of producing milk. It is clear that a farmer who keeps a certain number of cows has to meet these overhead expenses, and after doing so the only wise thing to do is to make certain that his cows have the proper feed to make possible the full use of their producing ability.

Everyone familiar with prevailing conditions knows that insufficient and improper feeding is the limiting factor in the milk production of probably the majority of the dairy cows of the country. The average production in the better developed dairy states is not much over 160 pounds of fat annually. These same cows with better feed could easily average above 200 pounds of fat. The Iowa Experiment Station a few years ago purchased for experimental purposes a group of cows from the Ozark region as best representing the scrub or unimproved stock. Yet these cows when given good care and feed averaged 169 pounds of fat, which is more than the average of the United States. The University of Minnesota some years ago purchased at the stock yards a group of cows of unknown breeding to be used in a demonstration of breeding by means of a pure-bred sire. Yet this group averaged 196 pounds of fat when given a good ration. These examples are given to show the importance of feeding and the possibilities of improvement, especially among those herds representing conditions average or below.

Turning Cows on Pasture in the Spring. Every owner of a cow welcomes the time when the animal can be turned out to pasture. Not only is the labor and expense connected with winter feeding done away with, but experience has taught that the herd may be expected to give the best results of the year during the first two months on pasture. In changing from dry to green feed it is best to go somewhat slowly, especially with heavy-milking cows. The young immature grasses are mostly water, containing often not over 10 per cent of dry substance or less than milk itself. It is almost impossible for a heavy-milking cow to eat enough of such watery food to supply the necessary nutrients. Another reason for making the change slowly is the effect upon the taste of the milk. When a cow is changed suddenly from dry feed to grass the milk may be given a strong taste; while if this change is made gradually, little or no change in taste is noticed.

A common mistake is to pasture too closely in the fall and to turn out too early in the spring. The cattle should be kept off the pasture until the grass is well started. Grass can only grow by having leaves above the ground in contact with air and sunshine. If the stock are turned out to graze while the grass is very short, the growth of the grass is slow, because it has no chance to get enough leaves to prepare its food.

Grain Feeding on Pasture. There is some difference of opinion on this question, from the standpoint of economy. There is no question but that a cow will produce more milk if fed grain while on pasture; and if a large yield is of more importance than economy of production, grain should certainly be fed. The cow that gives a small average quantity will produce but little more, if fed grain while on pasture. However, with the heavy-producing cow the case is quite different, and it is necessary that she be fed grain if she is to continue on the high level of production long. The necessity of feeding grain to the high-producing cow arises from the fact that she cannot secure a sufficient amount of nutrients from the grass alone, and must have some concentrated feed in the form of grain in order to continue to produce large quantities of milk.

A cow producing 35 pounds of average milk daily requires about 30 pounds of dry matter in her feed. Fresh pasture grass contains not over 25 pounds of dry matter to the hundred. A cow producing the very moderate yield of 35 pounds daily would require close to 150 pounds of grass.

The physical exertion necessary to merely gather this amount of grass and to masticate and digest it is clearly a hard day's work. While it is possible under the best conditions of pasture for a cow to gather and digest sufficient feed for this yield of milk, only too often the grass is short and it becomes clearly impossible for the animal to gather the required food. With higher-producing animals the conditions are still more difficult.

Experiments by Roberts[1] covering four years showed that, while an increase in milk yield was secured from grain feeding, it was not economical to produce it in this way. In their tests, about an additional pound of milk was secured for each pound of grain fed. In these experiments the pastures produced an abundance of nutritious grasses, and the average production was not high. It was observed, however, that the cows fed grain during the summer gave better results after the grazing period was over than those not having received grain. This is also a matter of common observation, and should be taken into account in considering the advisability of feeding grain. The point is that the cows which were fed grain stored a considerable quantity of surplus nutrients on their body, which were afterwards available for the production of milk.

---

[1] Bulletins 13, 22, 36, 40, Cornell University Experiment Station.

A compilation from reports of cow testing associations in Minnesota showed the following:

	Pasture Only	Grain and Pasture
Number cows	700	300
Average fat yield	238	302
Cost of feed	$41.87	$49.35

These figures indicate that by feeding grain worth $7.28, an addition of 64 pounds of fat was secured during the year which was worth $24.71 at 40 cents per pound.

When to Feed Grain. The condition of the animal and the amount of milk produced should determine how much grain, if any, should be fed while on pasture. No cow can produce a large amount of milk for any length of time on grass alone. A cow producing a pound of fat or more a day is in the class where it pays to feed grain. This would include a Jersey or Guernsey producing 20 pounds or more and a Holstein, Brown Swiss, or Ayrshire giving above 25 pounds.

The practice of the author in regard to feeding on pasture is about as follows:

Jersey or Guernsey cow producing:	
20 lbs. milk daily	3 lbs. grain
25 lbs. milk daily	4 lbs. grain
30 lbs. milk daily	5½ lbs. grain
35 lbs. milk daily	7 lbs. grain
40 lbs. milk daily	8 lbs. grain

Holstein, Shorthorn, Brown Swiss, or Ayrshire producing:

25 lbs. milk daily	3 lbs. grain
30 lbs. milk daily	4 lbs. grain
35 lbs. milk daily	5½ lbs. grain
40 lbs. milk daily	7 lbs. grain
50 lbs. milk daily	9 lbs. grain

It must be kept in mind that this applies only when pastures are abundant. Where a small amount of grain is fed to a cow on pasture, any farm grain such as corn, oats or barley serves the purpose. The grass supplies a liberal amount of protein and little attention is necessary to the protein content of the feed.

When liberal grain feeding is necessary—for example five pounds or more daily—some attention should be given to the grain ration used that it contain more protein and have variety and palatability. In fact, the same mixture as that used during the dry feed can be used with advantage.

Providing for Periods of Short Pasture. As long as fresh pasture grasses are abundant, the ordinary cow is about as well provided as she can be to produce milk economically. Unfortunately the season of abundant pasturage is often short. In many localities a dry period, often of several weeks, occurs during the middle or latter part of the summer, and the pastures become short and insufficient to maintain a full flow of milk. This season is often the critical time of the year for the dairy cow. It is probable that as much loss occurs one year by lack of feed at this time as occurs from improper feeding during the winter season. When the season of dry feeding arrives, the farmer expects to feed his stock, and is prepared for it. On the other hand, as long as the cattle are on pasture and the field work is pressing, the tendency is to let the cows get along the best way they can.

On a large proportion of the farms, the cows are fresh in the spring, and give a good flow of milk while the pastures are good; but when hot weather, flies, and short pastures come, the flow drops from one-half or two-thirds, and the cows producing but a small amount in the winter when the price is the highest. It is almost impossible to restore the flow of milk to the original amount after it is once allowed to run down from a lack of feed.

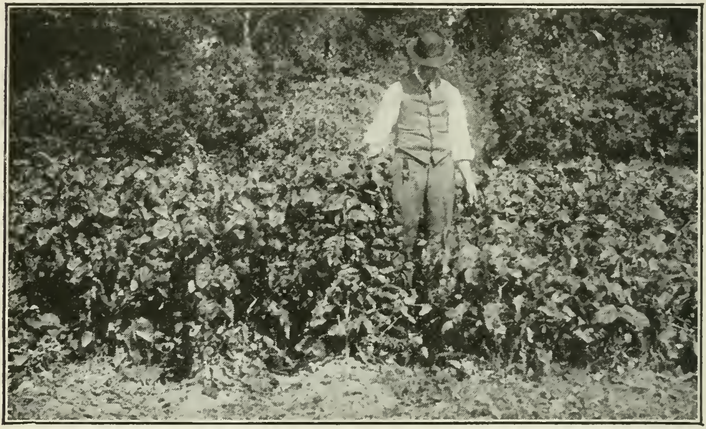


FIG. 75. A crop of cowpeas grown in Missouri as a soiling crop. The dairy farmer should make some provision to supplement short pastures. If a cow is allowed to decline in milk as a result of poor feed she cannot be brought back later in her milking period by improving the ration.

To make large returns from the cow a large yearly production must be had; and to do this, the flow of milk must be kept up for ten or eleven months in the year. It is the nature of blue grass—the most widely used pasture grass—to grow freely in the early summer, then to rest until fall. This leaves a period in midsummer, where blue grass is depended upon for pasture, when the pasture is apt to be short.

The Relative Economy of Silage and Soiling Crops for Summer Feeding. It is possible to hold up the milk flow by heavy grain feeding, but this is unnecessarily expensive. Provision should always be made to have a succulent feed on hand to supplement the pastures.

The choice as to the feed to be used will usually be between silage and soiling crops. It has been found experimentally by both the Wisconsin and the Iowa Experiment Station that silage and soiling crops are equally efficient as a supplement to pastures. The decision as to which should be used will therefore be made on other grounds. Silage can be grown more cheaply on most farms than soiling crops. It is evident that the labor expense will be less to raise a field of corn for silage than it is to plow, work, and plant a number of small plots at different times. The expense for seed is also decidedly less when corn is used than when a variety of soiling crops are grown. The most important advantage of silage is in connection with the harvesting. The harvesting of corn for the silo is done at one time. A force of men is organized and works full time with the help of efficient machinery. The soiling crops, on the other hand, have to be cut in small lots daily and handled largely by hand labor.

The difference between the yields of silage and soiling is not great. Silage has an advantage over soiling crops in that it is somewhat more mature when cut. The figures below show the average results for three years reported by the Wisconsin Experiment Station.

	Yield per Acre	Total Dry Matter per Acre	Crude Protein per Acre
	Tons	Lbs.	Lbs.
Corn silage	15.0	8,850	810
Corn, soilage	13.3	6,633	585
Peas and oats, soilage	9.3	4,450	570

These figures show that corn yielded more total nutrients and protein than peas and oats used for soilage. A comparison with alfalfa, however, would be somewhat less favorable to corn silage.

Disadvantages of Silage. A lack of variety is probably the greatest disadvantage of silage, especially when fed both winter and summer. Soiling usually includes several crops and among them some of the legumes which supply both protein and mineral matter in much larger quantities than corn. Where corn silage is fed, a liberal amount of protein must be supplied in concentrates or in legume hay. Another difficulty in feeding silage is that at least two inches must be taken off the entire surface of the silo daily to prevent spoiling during warm weather.

The Summer Silo. In order to insure the keeping of silage it is necessary to have a silo of small diameter in relation to the size of the herd. For summer feeding a silo 12 feet in diameter is ample in size for 30 cows. For this reason when the herd does not exceed 15 cows the use of soiling crops is generally advisable. The author has been able to keep silage in good condition during the summer where a few animals were fed from a silo by means of a canvas cover attached to an iron hoop of such size that it could be raised and lowered in the silo. The canvas was made air-tight by painting with melted paraffine. The cover was raised from the surface only while the silage for feeding was removed. If the silage in a summer silo is not needed, or only partially used at silo-filling, any spoiled material on the surface should be removed and the new silage can be put in on the old without any danger of spoiling.

Feeding Soiling Crops. Soiling crops may be fed either in the pasture, or in the barn. When feeding in the pasture is practiced, some waste results from tramping and fouling with manure. Feeding in the barn requires more labor but saves feed, and the cows will do better if kept in the barn in the middle of the day and protected from the flies by darkening the barn. Soiling crops are generally cut daily but may be kept over one day by piling in the shade. Soiling crops are usually fed once a day when scattered on the pasture, and twice a day when fed in the barn. From 40 to 70 pounds a day is the amount usually fed as a supplement to pasture. When fed as the sole roughage, up to 100 pounds daily will be required for the mature animal.

Winter Feeding and Maintaining Summer Conditions Throughout the Year. Every owner of a dairy herd knows that normally his herd reaches the maximum production in early summer when the pasture grass is abundant and other conditions ideal.

This suggests that the problem of the dairyman is to imitate these conditions of early summer during the remainder of the year. This is exactly what the careful dairyman and skilled feeder does, and results correspond closely to the success with which these summer conditions are maintained. These conditions which bring the maximum production in early summer and which should be maintained the remainder of the year may be described as follows:

1. An abundance of palatable food
2. A succulent feed
3. A sufficient supply of protein
4. Moderate temperature and comfortable surroundings

Amount of Feed. The first condition given as typical of the summer feeding is an abundance of palatable food, and on this point is made one of the most common mistakes in feeding cows under conditions of dry feed. In producing milk, the cow may be looked upon as being in a way a milk-producing machine which we supply with a certain amount of raw material in the form of feed, and which manufactures this raw material into milk. The same rule holds as in the running of any other manufacturing plant: it is run most economically near its full capacity. Everyone who feeds animals should thoroughly comprehend that, first of all, the animal must use a certain porportion of its food to maintain the body. This is the first requirement of the animal, and it is the first use to which it puts its food. This is called the ration of maintenance, and it is practically a fixed charge. That is, it is practically the same whether the animal is being utilized for maximum production, or is merely kept without producing any milk at all.

In the case of an ordinary dairy cow this ration of maintenance amounts to from 50 to 60 per cent of all she can consume. In the case of a heavier-producing animal—for example, one producing from 1 to 1¾ pounds of butter fat per day—this ration of maintenance amounts to from 40 to 50 per cent of the total feed of the animal. It should be clear that, after going to the expense of giving the animal the necessary amount to keep her alive, it is the poorest economy to refuse to furnish the other 40 to 60 per cent, which she would utilize exclusively for milk production. On the average farm this is one of the most common mistakes made. The importance of liberal feeding for economical production can be easily understood from Fig. 76.

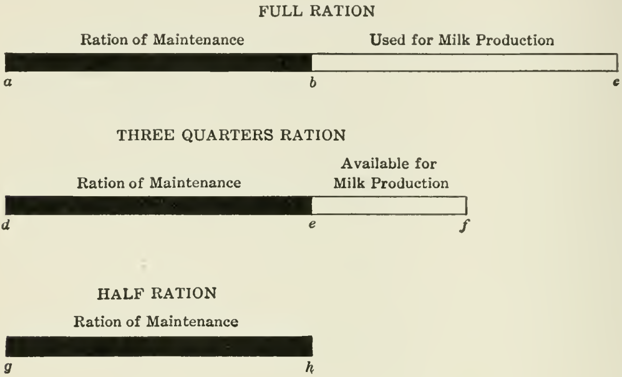


FIG. 76. The economy of liberal feeding

A good cow requires half her ration for maintenance, leaving half for milk production. If her ration is reduced 25 per cent, the cut comes entirely on that available for milk which is reduced 50 per cent. Producing milk, like operating a factory, requires certain overhead charges, in this case maintenance, and economical manufacture of milk requires that as much raw material in the form of feed be supplied as the animal can utilize above the ration of maintenance.

The first illustrates the proper feeding of a heavy-producing cow, which is the one usually underfed. The line *a* to *c* represents the total capacity of the animal for food, or a full ration. The first half, from *a* to *b*, represents the amount of food required to maintain the animal's body, or the ration of maintenance. The second half, that portion from *b* to *c*, represents the proportion of the food used for the production of milk. In this case there is no fat being produced on the animal's body, and the cow is supposed to be of such dairy quality that all the feed she can eat in excess of that required for maintenance is used for milk production.

The line below represents what would happen if the feed of this animal were reduced one-fourth. The ration of maintenance remains practically the same as in the first case. The amount represented by the line *d* to *e* is the amount required to maintain the animal's body, which is the same quantity as in the first case; however, the cut of one-fourth on the ration will be seen to come entirely on that available for milk production, and reduces that amount one-half.

Drawing on her reserve. Suppose that the ration of such a cow be still further reduced to one-half of the full ration, or that required for maintenance alone, as represented by the third line. In this case the cutting down of the ration one-half would remove all available feed for milk production. However, the animal would not cease producing milk at once. This is a point of great importance in feeding cows, and a lack of such knowledge leads to serious errors in feeding. The milk-producing function is so strong that the cow will continue to produce milk for some time, even when the feed is insufficient, utilizing the reserve material which has been accumulated in the body in the past. This always happens in the case of a heavy-milking cow during the first few weeks after the birth of the calf. At this time, it is not generally possible, and not desirable on account of the condition of the animal, to feed her a sufficient quantity of feed to supply the nutrients necessary to produce the milk; and even if the feed were offered, the appetite is not usually strong enough to cause the necessary amount of feed to be taken to prevent loss in weight. As a rule, all heavy-milking cows decline in weight for the first two or three weeks, and occasionally for ten weeks, after calving, which means that milk production has been in excess of the feed supplied for that purpose. The same thing happens in the case of the cow that is not fed a sufficient ration for the amount of milk that she is producing. She may continue to produce considerable milk for awhile by drawing on the reserve material of the body, but as soon as this reserve is exhausted, the production of milk must come down to the amount available for this purpose, above the ration of maintenance. When the feed is in excess, the cow begins to store reserve material on her body. If the amount of milk produced by a cow varied directly with the feed, and she did not store up nutrients at one time and draw on reserve material at another, it would simplify the problem of feeding very much, and result in more economical feeding at all times.

Avoiding Overfeeding. While the statement and illustration given apply to one class of dairy cows, there is another class to which it does not apply, and with which it would lead to a serious mistake in feeding from an economical standpoint. This group includes those of lower productive capacity, which are liable to be overfed, especially when they are in the herds of dairymen, who realize the necessity of liberal feeding. The proper feeding of this group of animals can be made clearer by Fig. 77.

The line *a* to *d* represents the amount of feed that an animal of this class will consume; *a* to *b* represents the ration of maintenance, as before. In this case, however, the capacity for making milk is not equal to the capacity of the animal for utilizing feed in excess of that required to maintain the body. The amount which the animal is capable of utilizing for milk production is represented by that portion of the line *b* to *c*, while the animal's appetite is equal to the total line *ad*. This gives a surplus, *c* to *d*, which is not utilized for milk production, but which will be used for storing fat on the animal's body; and we will have the cow gaining in weight while she is producing milk. This gain in weight will be of no value as far as milk production is concerned, except that it is of some value as a reserve material to be drawn upon at some other time when feed is not supplied in sufficient amounts; but it is not economical nor desirable to fatten dairy animals with the expensive feeds which are fed to cows in milk. That portion of the feed represented by the line *cd* should be taken from the ration. This means reducing her feed to take off the amount used for storing fat on the body—in other words, to feed her only what she will utilize for milk production—and feeding enough to maintain a practically uniform body weight. In every large herd where the amount fed is not carefully regulated, we find errors made in both these classes. We find the heavy-producing cows being underfed and we find the light-producing cows being overfed and allowed to accumulate fat.

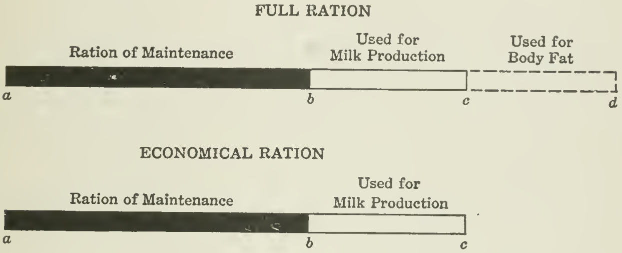


Fig. 77. How to avoid over-feeding

A cow with a limited capacity to produce milk, if fed more liberally than necessary, gains in weight. Economical feeding consists in supplying all the feed the animal will use for milk production but nothing is gained by feeding beyond this point. Economy in practical feeding requires that cows be fed in proportion to their milk production.

Relation of Live Weight to Proper Feeding. The live weight of a cow is one good index of whether the cow is being fed a proper amount or not; but good judgment in regulating the ration must be used by observing this condition. We must expect a cow to lose weight in the first few weeks of her milking period; but after this period is past, there is no reason why she need change greatly in weight for several months, and this is the period when the greater part of the milk production is secured. It will not mean, of course, that the animal should not be allowed to gain in weight during the latter end of the milking period; this is necessary on account of the development of the fetus, and because it is natural for the animal to carry some fat on her body at calving time.

It does mean, however, that in order to feed a herd of cows economically it will not do to feed them all the same quantity of grain whether they are giving a gallon of milk a day or whether they are giving 4 gallons, and it means that when a cow in the middle of her lactation period is putting on weight she is being fed more than she needs and will give just as much milk if the feed is cut down somewhat. It also means that if a certain animal is losing in weight sufficient feed is not being given, and that if the deficiency is not supplied it will not be long before the milk production will come down to correspond with the amount of feed available.

Feeding as Individuals. In connection with the discussion of the amount of feed, it needs to be pointed out that it is only possible to feed a bunch of cows economically when they are fed as individuals, and not as a herd. A too common practice even in otherwise well-managed herds is for all animals to be fed the same amount of grain, regardless of the time they have been in milk or of the quantity of milk which individual cows are producing. Such feeding always lacks economy, because the high-producing cow does not get enough, and while she may milk very well for a short time, she soon comes down to a lower level, while the lighter-producing cow usually gets too much and accumulates fat. The production of many herds could be increased to a large extent without any increase in the amount of feed used by distributing it properly among the individuals. It requires some attention to adjust the ration to each individual but the time spent in this direction gives good returns.

Amount of Grain and Roughness to be Fed. The cow, being adapted by nature for consuming bulky feeds, does not feel satisfied unless there is sufficient bulk to the ration given at all times. An animal that is fed too much grain in proportion to the amount of roughness may seem hungry, while she really has a sufficient amount of nutrients, but so concentrated that it does not have sufficient bulk. The cow should be fed practically all the roughness she will eat up clean, at all times, and the difference in the rations fed to cows producing different quantities of milk should be in the grain ration.

A cow on a good ration or roughness will maintain herself and produce a certain amount of milk. If she be a cow of much dairy capacity, she will not produce milk to anything like her maximum without having a portion of her ration in the form of concentrates. The point is, the milk-producing function has been developed to such an extent that it is impossible for the digestive apparatus of the cow, efficient as it is, to extract sufficient nutrients from coarse feeds to supply the enormous drain upon the body resulting from the secretion of large quantities of milk.

The mistake is at times made of assuming that cows all receive the same ration when a uniform grain ration is fed. The difference in the amount of roughness consumed is generally overlooked in these cases, since the animals can eat at will. If a grain ration be increased which is already ample the animal consumes less roughness and may not consume any more nutrients than before, although usually such is the case on account of the greater palatability of the concentrates. In herds where all cows receive the same grain ration, close observation will show that the light milkers are consuming less forage than the heavier milk producers. Since roughness is usually a cheaper source of nutrients than grains, it is desirable to have a liberal amount of this class consumed. The amount can be regulated by giving the animal all she will consume of the roughness and, in addition, concentrates to supply the nutrients necessary for the amount of milk she is producing.

Rules for Practical Feeding. The most accurate means of determining the amount of feed required is by calculation based upon one of the feeding standards as explained in another chapter. However, practical feeders have never made extensive use of feeding standards, and for their use the following rules are of service as a general guide for feeding.

1. Feed all the roughage the cows will eat up clean. The roughage should include a succulent feed and a legume hay.

2. Feed 1 pound of grain a day for each 3 pounds of milk by Guernsey or Jersey and 1 pound to each 4 produced by a Holstein. Other breeds are intermediate. The grain mixture should contain at least three concentrates and more is desirable for high producers.

The rule concerning the amount of grain to feed applies only when good roughage is fed, including a succulent feed such as silage or roots and a legume hay. In case inferior roughage such as timothy or red top hay, or corn fodder is used, the concentrate allowance should be somewhat heavier if a satisfactory production is to be maintained.

Succulent Feed. The second condition given as typical of summer rations is, that the feed is of a succulent character. The cow seems especially adapted for a feed of this character and cannot do her best unless it makes up part of the ration. The term "succulent" is applied to such feeds as grass, silage, and roots—feeds containing the original juices in contrast to those that have been dried. A succulent feed has a value outside of the actual nutrients it contains, on account of the favorable effect upon the digestion of the animal. In the corn belt, corn silage furnishes the best means of supplying this class of feed. In other regions, especially north of the corn belt, the growing of root crops such as mangels or rutabagas is widely practiced, and supplies this desirable addition to the ration in an entirely satisfactory form. Root crops are also to be recommended when the herd is too small to justify the erection of a silo.

The Protein Supply. The third reason for the excellent results from good pasture grass is that an ample supply of protein is available.

On the ordinary dairy farm the most common mistake made in feeding, next to that of not feeding liberally enough, is the use of a ration that does not furnish the necessary amount of protein. Fresh pasture grass supplies sufficient protein, but the winter ration, especially where corn and timothy hay are standard, is often decidedly lacking in this constituent. The protein of the milk, a portion of which is seen as curd in sour milk, requires for its manufacture the same class of substances in the feed. Nothing else can take its place.

If a cow has sufficient other material in her feed to produce 30 pounds of milk but, on account of a shortage of protein, produces but 15, it is useless and wasteful to increase the ration further. The proper procedure is to change the ration by the addition of a small amount of a concentrate high in protein.

The practical feeder should become familiar with the composition of the common feed stuffs and use this knowledge as a basis for selecting the ration to be used. The classification which follows will assist in fixing the relative value of common feeds in regard to the content of protein and total digestible nutrients.

ROUGHAGE

LOW IN BOTH PROTEIN AND TOTAL DIGESTIBLE NUTRIENTS

	DIGESTIBLE CRUDE PROTEIN PER CENT	TOTAL DIGESTIBLE NUTRIENTS PER CENT
Wheat straw	0.7	36.9
Barley straw	0.9	42.5
Oat straw	1.0	45.6
Rye straw	0.7	41.2
Corn stover	2.1	46.1
Cottonseed hulls	0.3	37.0

Medium in Protein and Digestible Nutrients

	Digestible Crude Protein Per Cent	Total Digestible Nutrients Per Cent
Corn silage	1.1	17.7
Corn fodder, dry	3.0	53.7
Timothy hay	3.0	48.5
Prairie hay	4.0	47.9
Red top hay	4.6	53.2
Sorghum fodder, dry	2.8	52.1
Kaffir fodder, dry	4.1	52.9
High in Protein		
Alfalfa hay	10.6	51.6
Red clover hay	7.6	50.9
Alsike clover hay	7.9	47.3
Soybean hay	11.7	53.6
Pea and oat hay	8.3	48.8
Cowpea hay	13.1	49.0
Grains and By-Products **Low in Protein**		
Corn	7.1	81.7
Corn bran	5.8	73.1
Wheat	9.2	80.1
Oats	9.7	70.4
Rye	9.9	81.0
Barley	9.0	79.4
Kaffir corn	9.0	80.0
Dried beet pulp	4.6	71.6
Molasses cane	1.0	59.2
Medium in Protein		
Wheat bran	12.5	60.9
Wheat middlings	15.7	78.2
Dried brewers' grains	21.5	65.7
Dried distillers' grains, corn	22.4	88.9
Malt sprouts	20.3	70.6
High in Protein		
Cottonseed meal, choice	37.0	78.2
Linseed meal, new process	31.7	75.9
Gluten meal, high grade	30.3	84.0
Ground soybeans	33.2	94.1

CHAPTER XXVI

FEEDING FOR MILK PRODUCTION *(Continued)*

Palatability. An animal will give the best results when it relishes its feed. Often the dairy cow does not consume as much feed as she could use because it is not palatable. A ration could be prepared, for example, timothy hay and corn fodder for roughage and malt sprouts and cottonseed meal for concentrates that would conform to the feeding standard, but the cow would not do well on it. A common example is feeding young heifers corn silage, timothy hay, and a limited amount of grain. Although the heifers have all the feed necessary before them they will limit the amount consumed by them to such an extent that normal growth will not be secured.

The greatest variation in palatability occurs in the roughage. A chemical analysis does not show much difference in composition between hay cut at the proper stage of maturity and that cut in a more mature condition. The real feeding value, however, is quite different on account of the loss in palatability. The coarseness of stem and the conditions of curing are also factors in the palatability of hay. The feeding value of hay depends almost as much upon its palatability as upon its composition.

It is not unusual at all for some concentrates to be refused when first offered, although they are eaten readily when the animals are accustomed to them. Even corn silage is sometimes refused when it is first offered. Malt sprouts are among the most unpalatable of concentrates, and rye products and cottonseed meal are also in this class, although to a less degree. The concentrate part of the ration is usually more palatable when three or more kinds are fed in a mixture.

Variety. It is a common belief that an animal loses its appetite if continued on the same ration for some time. This condition does at times develop if the ration is confined to a single roughage and the grain which is fed lacks variety. In case a ration lacking in variety has been fed for some time, it is advisable to make a change to insure that the animal will continue to thrive. However, if a sufficient variety of feed stuffs is included in the ration, the animal does not tire of its feed and can be continued on the same ration for long periods without change. Under these conditions no advantage is gained by changing the ration.

The most skilled breeders of high-producing cows select a ration carefully, giving attention to variety and succulence, and then make as few changes as possible. For a medium-producing animal three grains in the mixture are sufficient. For very heavy-milking animals the number should be increased to at least five or six.

The recent discoveries regarding the difference in the quality of proteins offers a probable explanation of the favorable effect of having a variety of concentrates in the ration fed. Protein is made up of amino acids, of which about twenty are known. The animal has to have certain ones of these, in order to maintain itself, to produce milk, or to grow. Protein from a single plant may be deficient in some of these amino acids. Corn protein alone, for example, is deficient in some of these amino acids, and for this reason animals do not thrive to advantage on corn alone. When the ration contains grains or by-products from several plants, the deficiencies of one will usually be made up by another.

For the reason given in selecting the ration, it is well to have feed stuffs from as many different plants as possible. The advantages of variety are well known to experienced herdsmen who are caring for cows on official test. A typical ration used for this purpose was composed of distillers' grain, wheat bran, oats, gluten feed, cottonseed meal, and linseed meal. In this case, at least six plants are represented in the mixture.

Proportion of Nutrients from Roughage. The digestion of the bovine is especially adapted for utilizing large quantities of roughage. In fact the real purpose of the bovine as a servant of mankind is the conversion of coarse materials not suitable for human food into forms that can be used by man.

Economically it is desirable on the farm that roughages furnish the largest possible proportion of the ration. Digestible nutrients are as a rule supplied cheaper by roughage than by concentrates. For example, with clover hay at $8 a ton, 100 pounds of digestible nutrients cost $1; in corn at 65 cents a bushel, 100 pounds of digestible nutrients cost $1.30.

There are conditions, however, under which the cheapest source of nutrients is not roughage, but grains. The margin between the farm price and the retail selling price is much larger for hay than for grains. Baling hay for market, hauling to the shipping point, and the cost of transportation and of selling at retail add a large margin to the original cost. For this reason in recent years, where feed is purchased, nutrients have been cheaper in concentrates than in hay. This condition has been common in the Eastern States for several years. In 1922, the local price of alfalfa hay in carload lots was $24, and of corn 50 cents a bushel. At these prices, 100 pounds of digestible food in alfalfa cost $2.32 and in corn $1.04. It is clear under these conditions that for one buying all the feed used the economical thing to do is to supply as many of the required nutrients as is practicable in the form of grains.

The proportion of the total nutrients that a dairy cow can get from the roughage in a ration depends upon the amount of milk she is producing. With liberal feeding of the very best of roughage—for example corn silage and alfalfa hay for winter feeding and pasturage for summer—it is possible for a herd of well-selected cows of the special dairy breeds to produce an average of from 175 to 200 pounds of butter fat in a year. As the production increases, the proportion of the total nutrients which must be fed in the form of concentrates increases. A herd producing from 275 to 350 pounds of fat yearly received about 45 per cent of their nutrients in the form of concentrates. Cows on official test producing 600 pounds of fat require 60 to 65 per cent of their ration in the form of grain, while for a yield of 700 pounds of fat or more in a year the proportion of nutrients from concentrates usually reaches 70 per cent.

This fact is an important consideration in the question of what level of fat production is the most economical. It is clear that if the cow producing 600 pounds of fat or above can do so only by using mostly grain, she does not meet the purpose of the typical farmer, who uses the cow largely to convert his roughage into marketable products. On the other hand, on account of the overhead expense, a very low-producing cow is not economical. Under farm conditions the most economical production is from 300 to 400 pounds of fat yearly.

In practical feeding it should be recognized that the concentrates should be fed in proportion to production and that high production inevitably means heavy feeding of concentrates.

Lightness of Ration. Among cattlemen the term "light ration" is used with two distinct meanings. The term "light ration" is used with the same meaning as "scant ration," or in contrast to a liberal ration. The other meaning, and the one covered by this paragraph, refers to the bulkiness of the feed mixture used; or, another way to define it is weight in proportion to volume. In this sense, a light ration is one that has a large bulk in proportion to its weight, and a heavy ration is the reverse. Ground oats, bran, and dried beet pulp are examples of light feeds; cottonseed and linseed and middlings are examples of heavy feeds. The general character of the ration regarding lightness will depend upon the proportion present of the heavy and light feed stuffs.

There is a decided advantage, especially to high-producing cows, in the concentrate mixtures being of a light character.

A mixture of this kind remains porous when moistened and is easily penetrated by the digestive juices. For this reason it is digested much more readily than a heavy mixture, which forms a dough-like mass in the digestive tract and is not penetrated easily by digestive juices.

When the amount of grain fed is very limited, no special attention to the character of the ration regarding lightness is necessary, but for high-producing cows receiving a liberal ration it must always be taken into account. A heavy-milking cow may receive up to 20 pounds of grain daily. With such an amount to handle it is not surprising that every precaution must be taken to make conditions as favorable as possible for digestion. Bran and ground oats are especially useful to assist in lightening the ordinary ration. Dried beet pulp is the most effective of all common feeds in this respect. For this reason, where cows are receiving very heavy grain rations, as for example under official test conditions, beet pulp is generally made a part of the ration. It is wet twelve hours before use and at feeding time the concentrates are mixed with it.

A simple experiment will show the difference in rations with regard to lightness. To a mixture of corn meal, cottonseed meal, linseed meal, and wheat middlings add enough water to moisten the mass thoroughly, mixing it as the water is added. A doughy mass is formed that is almost impervious to water. To illustrate a light ration, a second mixture should be made containing all or part of the same ingredients, with the addition of an equal amount of wheat bran, ground oats, and dried beet pulp. This mixture when wet can not be made into a doughy mass but remains friable and is easily penetrated by the digestive juices.

Home Grown Rations. The dairy farmer is adverse, as a rule, to buying any more feed than is absolutely necessary. In general he is right in his feeling, although in case the home grown ration is clearly inadequate it will be economy, after going to the expense of keeping the herd, to buy what is necessary to get fair results. The proper course for him is to grow crops that will supply the necessary constituents of the ration as fully as possible.

The foundation of a good ration anywhere is a succulent feed and a legume hay. If a succulent feed of some kind can not be grown and kept for winter feeding it is questionable if dairying should be undertaken in a commercial way.

One reason why many farmers make the mistake of feeding rations short in protein is that it is easier—or they think it is—to grow feeds that are high in carbohydrates and lacking in protein. This is due principally to the large amounts of timothy hay and corn grown and used. A ration including corn fodder or silage, timothy hay, and corn would maintain a dry cow in good condition; a dairy cow, however, could produce but little milk even if fed liberally. With such a combination of home grown feeds the addition of rather liberal amounts of high protein by means of feeds like gluten feed, linseed, or cottonseed meal would be the only possibility of holding up milk production. The thing for the farmer to do is to raise on his own farm as far as possible the feeds he requires; and it is possible in many localities to produce practically all that is needed to make a balanced ration. The place to begin in considering the feeding of an animal is always with the roughness, since the character of the roughness determines to a large extent the kind of grain it is advisable to feed.

The cheapest source of home-grown protein usually is leguminous hays. The kind to be grown varies with locality. The most common legumes are alfalfa, red clover, soy-beans, and cow-peas. If an abundance of any one of these hays can be grown, the problem of making an economical balanced ration is very greatly simplified.

Corn is the greatest staple crop of the country. Either oats or barley is generally available. A ration of corn silage or roots to supply the succulent feed, and of clover, alfalfa, or other legume for the remainder of the roughage gives the foundation for a satisfactory and economical ration. Corn, oats, and barley, fed in a mixture including at least two of the three, supply the basis of a good grain mixture. From these alone can be made a ration satisfactory for a low-producing herd.

The addition of a small quantity of a concentrate rich in protein, such as bran or cottonseed meal, makes a ration adapted to heavier milk producers. The soy-bean is becoming an important crop over a considerable portion of the country. Ground soy-beans have a protein content not far below linseed oil meal. For this reason the possibility of growing all the protein needed by the ordinary herd in the form of soy-beans is very promising.

Mineral Matter in the Ration. Until recent years the problem of feeding was looked upon as one of supplying a sufficient amount of protein and of total digestible nutrients. While it was understood that the mineral elements were required it was assumed that a sufficient amount was present in any ration that supplied the necessary protein and total digestible food.

Recently evidence has been accumulating to show that the question of a sufficient supply of mineral matter must also receive attention. A number of minerals are needed by the body, among which are calcium, phosphorus, sulphur, magnesium, potassium, sodium, iron, and iodine. These substances are found in all tissues of the body. The bones are composed of a combination of calcium and phosphorus. The red corpuscles of the blood are rich in iron. Without a certain amount of calcium in the blood the heart will refuse to beat. The control of all muscles is accomplished through the action of certain of these minerals. A curious fact, found by experiments with animals, is that if an animal is fed a ration supplying an abundance of other food material but no mineral matter it will die quicker than if given no food at all.

With dairy cattle the critical period is during growth and when secreting milk. The mineral elements of which there is danger of deficiency are calcium and phosphorus. Three-fourths of the ash of the animal body is calcium, and it is this element that is most often lacking in the ration. The cow in milk uses a large amount of calcium in comparison with domestic animals kept for other purposes. Milk is rich in calcium, serving as one of the best sources of this element for human use. The amount present in milk varies slightly with the amount of other constituents, but it can not be influenced by the amount contained in the ration received by the animal. The same amount is secreted in the milk, regardless of the intake with the food.

In case the amount of calcium in the feed is not sufficient, the cow draws on her reserves. One of the striking facts concerning this subject brought to light in recent years is the extent to which it is possible for mineral matter, especially calcium, to be stored in the body in times of plenty and drawn upon in times of deficiency. Calcium and phosphorus are stored in the bones. Hart, McCollum, and Humphrey reported a case, on a ration low in calcium of a cow actually giving off calcium in her milk until 25 per cent of the total in her skeleton was used.

Forbes[1] also found that the heavy-milking cows used in his experiments regularly gave off more calcium than they received in their feed while in the early part of the milking period regardless of how they were fed. The reserves are replenished when the cow is dry or giving a small amount of milk. Forbes suggests that some of the well-known but unexplained facts concerning milk production are possibly the result of calcium exhaustion. For example, it is a common observation that a cow that has produced very heavily in one year usually falls considerably behind the next. The recognized importance of having the cow dry for a period and of conditioning before calving may be largely a matter of allowing the mineral reserves to become replenished.

Both Hart[2] and Forbes believe the lack of sufficient mineral matter in the ration may result in abortion. Hart found that cows receiving rations with less than .45 per cent of calcium could not carry their calves to full development. The mistake should not be made of interpreting these statements to mean that these authorities or the author believe lack of mineral matter rather than infection to be the chief cause of contagious abortion. There is considerable evidence, however, to indicate that poor rations may at least weaken the resistance of the animal to the infection and in this way increase the danger of abortion disease.

---

[1] Bulletins 295 (1916), 308 (1917), 330 (1918), Ohio Exp. Station. *Journal of Biological Chemistry*, Vol. 52, pp. 281–314.

[2] Research Bul. 49, Wis. Exp. Station (1920).

It should be understood that the cow gets most of her calcium from the roughages. Legumes are the best source of calcium of all feeds used. Corn and cereals and their by-products on the other hand are low in calcium but in general carry a rather liberal amount of phosphorus. One hundred pounds of alfalfa hay contain from 1 to 1.5 pounds of calcium, and corn .014 pound. One pound of alfalfa supplies approximately the same amount of this mineral as 100 pounds of corn. The best sources of phosphorus are wheat bran and cottonseed meal, although corn also contains a fair amount. Table 71 in the appendix gives the calcium and phosphorus content of common feeds. The amount of mineral matter in the soil and the rainfall are both important factors. Crops grown on acid soil or sandy soil are lower in calcium than those grown on better soil. A deficiency of rainfall also results in a decreased calcium content of the crop grown.

It is by no means certain that it is possible to recognize by any well marked symptoms when a herd is suffering from a calcium deficiency. Occasionally conditions are noted that are quite definite, but presumably these are only the extreme cases. When the animals show an abnormal appetite, eating dirt, chewing bones or stones, or gnawing boards or trees, the chances are that they have experienced a serious lack of mineral matter, either calcium or phosphorus. If a well-fed herd milks poorly in comparison with former years, and especially if a tendency is observed for the animal to have an unthrifty appearance, a shortage of mineral matter is suggested.

In ordinary herds there is little danger of a calcium shortage if legume hays are used. It is probable that very heavy-milking cows, however, may at times be unable to assimilate sufficient calcium from this source. Recent experiments reported by Hart and by McCollum indicate that the presence of a certain vitamine is necessary in order that the calcium may be used to the best advantage. This vitamine is supplied by green plants. This fact suggests that dairy cows should have access to pasture some time during the year in order to help restore the calcium reserves of the body.

Experimental results with regard to this subject are so limited as yet that it is impossible to say with any assurances to what extent animals can utilize mineral supplements to the ration. So far as our present knowledge goes, the best recommendation is to give the cattle access to steamed bone-meal. This can at least result in no harm and it may be decidedly beneficial. The plan recommended is the preparation of a mixture of four parts steamed bone-meal and one part common salt. This mixture should be kept before the animals in the same manner as is commonly done with salt. A satisfactory plan is the use of a feed box having two compartments, in one of which is kept a supply of salt and in the other the bone-meal and salt mixture. Calves and growing heifers as well as the cows should be given access to the bone-meal mixture. Cows in milk will at times consume up to 3 or 4 pounds a week.

Preparation of Feeds. *Grinding grain.* The grinding of grains increases the digestibility only in case the animal would not thoroughly masticate the unground kernels. The cow in milk, receiving as she does a rather liberal allowance of feed, fails to masticate a considerable proportion of whole grains such as corn or oats. The results which follow from tests made by Shaw and Norton are typical of what may be expected.

	Cows Per Cent	Heifers Per Cent	Calves Per Cent
Whole corn passed	22.8	10.8	6.3
Whole oats passed	12.1	5.5	3.0

The cows receiving a rather liberal ration showed a greater percentage loss than the heifers, while the calves were far below. A loss of from twelve to twenty per cent in feeding unground grain, as indicated by this test, fully justifies the common practice of feeding ground feed almost exclusively to cows in milk. With calves the loss is not serious. It was also found in this investigation that the composition of the whole grain passed was changed but little. Germination tests showed that 4.3 per cent of the corn and 10.6 per cent of the oats would still grow. These results justify the conclusion: that no owner of a dairy herd of any size can afford to be without a suitable feed grinder.

The only condition under which it is economical to feed unground grain is when the price of the feed is relatively cheap and the cost of grinding high. If no hogs are on hand to gather up the grain otherwise wasted it would ordinarily be economical when feeding cows in milk to spend if necessary a sum equal to 10 per cent of the cost of the grain fed in grinding.

Cutting and grinding hay. In Europe, where labor is cheap, the practice of running hay and straw through a cutting box is common. It is not practiced to any great extent in America. This treatment has no influence upon the proportion of the hay digested. Cut hay is not thrown from the manager and wasted by tramping to the same extent as the uncut. A larger proportion of the coarser parts are also eaten. It is only under exceptional conditions, however, that the cutting of hay is economical.

In recent years the grinding of alfalfa hay has become an important industry where this hay is grown abundantly. The hay is reduced to about the mechanical condition of wheat bran and is sold sacked. No experimental results are available regarding its feeding value as compared with uncut hay of the same quality. No increase in digestibility is probable. The advantages lie largely in the greater economy in shipping, storing, and handling. At times it serves a useful purpose as a means of lightening up a grain ration in the same manner as does dried beet pulp. The idea, encouraged by those interested in its preparation, that ground alfalfa ceases to be a roughage and becomes a concentrate is hardly to be accepted. The ground hay is hardly as palatable for cattle as the unground, especially when it contains considerable dust. The chief objection to alfalfa meal is its expense. Grinding roughage is an expensive operation and the market price ranges from 25 to 40 per cent above that of baled hay. This seems an unnecessary addition to the expense of the ration while the cow herself has a very good grinding apparatus and prefers to grind her own hay.

Cooking feed. There is no advantage in cooking feed for cattle. Extensive experiments with this subject were conducted many years ago. The results showed definitely that cooking in no way increases the value of a ration to the animal and in fact the protein is somewhat less digestible after cooking.

Steaming hay. Steaming hay before feeding was practiced to some extent about fifty years ago. The practice has recently been revived in some places in connection with the feeding of coarse hay, especially alfalfa. The main object sought by those trying it is to increase the proportion of the hay that is consumed. In the case of coarse hay, the proportion not consumed is rather large, and when hay prices are high this loss becomes a serious one. The steaming has been found to reduce the digestibility of the protein slightly. The reduction in the hay wasted is not sufficient to justify the labor and expense of the practice.

Soaking feed. Under ordinary conditions nothing is gained by feeding the grain ration in a wet condition, or in the form of a slop. Wetting the feed results in a decrease rather than an increase in the palatability of the ration. When dried beet pulp is fed, however, there is a distinct advantage in soaking it for several hours before feeding. A common practice is to mix the concentrates with the wet beet pulp before feeding. Bran moistened with hot water, in which condition it is known as bran mash, is useful as feed for cows following calf-birth, or out of condition for any cause.

CHAPTER XXVII

FEEDING FOR MILK PRODUCTION (*Continued*)

FEEDING PRACTICE

Cause of Milk Secretion. As stated elsewhere, scientific investigation shows that milk secretion is primarily the result of a stimulating substance known as hormones acting on the udder. The hormones are produced by some ductless gland. A secondary factor in milk secretion is nervous reflex action, or the stimulation that comes to the nerves from the act of milking. In the early part of the milking period the action of the hormones is the chief cause of the milk secretion, while in the later stages of the lactation period the stimulation from this source has largely died out and the nervous stimulation from milking appears to be the chief factor. It is highly important to keep these facts clearly in mind as they have an important relation to feeding, as will be developed later.

The milk production of a cow is determined by two factors, the internal, or the stimulation applied to the udder from the inside, and the external, which includes feed and care. Having the cow in proper physical condition at time of freshening has been emphasized in another chapter. The strength of the internal factor is determined chiefly by heredity, but the physical condition of the animal at time of freshening modifies the intensity of this stimulation to a marked degree.

Proper methods for feeding the cow when she is dry have been discussed in a previous chapter.

Feeding After Freshening. After the calf is born, the cow should be given water—warmed if the weather is cold—and a small portion of roughage. A warm bran mash is especially to be recommended for use during cold weather. The grain fed during the first two days should be light and laxative in character. A mixture of oats, bran, and linseed oil meal fulfills these requirements. After two or three days the cow may be given the regular mixture received by the remainder of the herd, the amount to be increased gradually as her physical condition permits. If the udder is congested the grain must be kept to a low point until the inflammation subsides. A small or medium-milking cow may be put on full ration within a few days, but a heavy-milking individual requires greater care. Sometimes a full feed is not given until the end of thirty days or even longer. It is natural for a heavy-producing cow to lose in weight for a month or six weeks after freshening. After this period she should remain about uniform for several months; then as the end of her milking period approaches she normally again gains in weight.

How Much to Feed. The feeder should follow the milk production of the cow with the feed, rather than expect the milk production to follow the feed. The fresh cow gives milk as the result of the stimulation applied to her udder. If in good flesh she will for a time milk liberally even if nutrients have to be taken from her body for the purpose. In fact a heavy-milking cow is always underfed for a time. Her ration should be increased as rapidly as seems safe until enough nutrients are supplied for the amount of milk produced. The secretion of milk takes large quantities of nutrients from the body and the cow is very hungry just as is the man who has worked hard all day. A high-producing cow is a heavy eater because she requires the nutrients to replace those taken from her body to produce milk. However, she is not a heavy producer of milk as the result of being a heavy eater.

If the cow is in good condition when she freshens and is fed somewhere near correctly she will show soon after calving what her capacity of milk production is. If a cow produces 40 pounds of milk daily soon after being fresh, be sure to feed her enough to supply what is needed to produce 40 pounds of milk. If she received only enough for 30 pounds she will draw on the nutrients stored in her body for awhile, then gradually come down to 30 pounds. The thing to do is to be sure to give her enough for 40 pounds while she is producing that much. Many cows that are given a reputation for lacking in persistency of milking really did not hold up as they were capable of doing on account of lacking the proper ration. If a cow that is already receiving a ration ample to supply everything needed for the milk she is producing goes down in milk, she cannot be brought back by increasing the feed. The thing to do is to reduce the grain in proportion to her drop in milk. It should be remembered that giving the cow the proper ration to produce milk does not result in milk secretion unless the stimulation to give milk is present in the cow. In other words, follow the milk production with the feeding and do not assume that the milk flow can be pushed up and down at will with the feed. A common error resulting from a failure to understand these facts properly is to attempt to judge the value of a certain feed by putting it in the ration of cows already several months in milk. When a cow has largely lost the stimulation to give milk which she received at the time of freshening, the effect of a change of feed is slight. The amount of grain fed should be carefully adjusted as the milk production declines, due to the advance in lactation. If a cow goes down in milk and is already receiving sufficient feed it is hopeless to attempt to bring her back by increasing the amount fed. The proper course is to decrease the grain allowance in proportion to the decline in milk production unless it is desirable to have the animal gain in weight.

Order of Feeding. Regularity in time and manner of feeding is of more importance than any definite order of feeding. As a rule, about half of both concentrates and roughness should be fed at night and the remainder in the morning. The grain is usually fed first and the hay feeding reserved until after the milking is completed, to avoid filling the air with dust, which contaminates the milk. Silage should be fed immediately after milking, to prevent the odor from gaining access to the milk. The cow is a creature of habit, and the same routine should be followed. She may be taught to demand her grain ration when milking, but will give down her milk just as well if always fed either before or after milking, and will not look for it at the time of milking. When heavy-producing cows are milked oftener than twice daily the number of feedings are usually likewise increased.

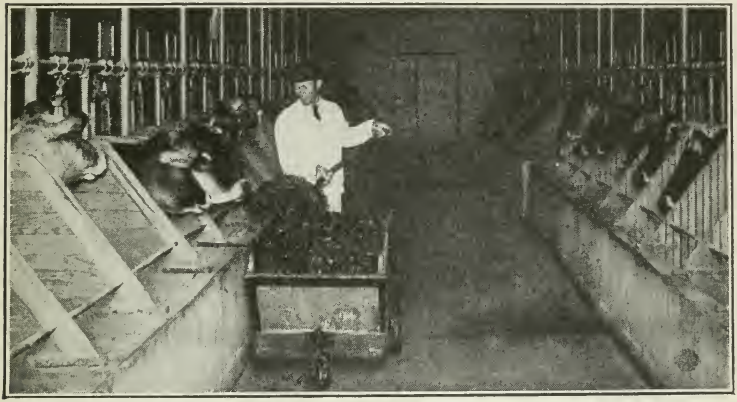


Fig. 78. Feeding silage from a truck. A truck is especially useful in feeding a heavy feed like silage. The concentrates are generally fed first followed by the roughage. Where silage and hay are fed, some feed both twice daily, others prefer to feed the silage at one feed and the hay at another.

Limits of Grain Feeding. The system of feeding dairy cows in this country calls for a liberal feeding of concentrates in the form of grain or by-products. The European practice on the other hand calls for a minimum allowance of concentrates, usually by-products, with a maximum feeding of roots or roughage. This wide variation in practice suggests that conditions such as price of feed, market value of product, and cost of labor must be the determining factors. In America grain is abundant and cheap in comparison with European conditions. The market value of dairy products is about the same, while labor is much higher here.

The evidence available indicated that with the best of roughage alone, for example corn silage and alfalfa hay, a herd of well selected Holsteins may be expected to average 5,500 pounds of milk. The same herd, if given a reasonable amount of grain in addition will average about 8,000 pounds. With heavy grain feeding and three-times-a-day milking the yield can be further increased.

The question confronting the farmer who is interested in total profits rather than total yields is how liberally should grain be fed. The question is by no means easy to answer because so many factors are involved. One of the first considerations is the producing ability of the cows. It is possible under favorable conditions, as pointed out, to produce an average of 150 pounds of fat yearly on a ration exclusively of roughage. It is clear that given a herd with the average capacity to produce only 150 to 200 pounds of fat that heavy grain feeding would be a mistake. Cows of this class can eat and digest enough roughage to nearly supply the requirements, and only a limited amount of grain is necessary in addition. If a large amount of grain is fed the cow does not produce more milk because her capacity is limited. She merely eats less roughage and takes a correspondingly high proportion of her nutrients from the costly grain.

On the other hand, given a cow with the capacity for high milk production, only under extreme and unusual conditions is it economical to limit her feed. Economy calls for a full use of her producing capacity. The overhead expense, in maintenance of the animal, the necessary labor, barn room, and the variety of other expenses have to be met. These are practically the same when the cow is producing 150 pounds of fat as when producing 300 pounds.

The situation can be best illustrated by an example. It will be assumed that Guernsey cows are on hand with a capacity to produce 350 pounds of fat in a year. In order to have a complete statement it will be assumed that these cows are fed the same ration the year around and that the milk is produced at the same rate throughout the year. These assumptions simplify the problem without changing the principles involved in the least. The ration selected will be corn silage, alfalfa hay, ground corn, wheat bran, and oil meal; and the present wholesale prices will be used, except in the case of silage, which has no market price and which will be figured at $5 per ton.

A production of 350 pounds of fat from a herd of Guernseys averaging 5 per cent of fat would require 7,000 pounds of milk, or 19.1 pounds daily. Using the Morrison Standard the daily requirements for those cows would be as follows:

	LBS. DIGESTIBLE PROTEIN	LBS. TOTAL DIGESTIBLE NUTRIENTS
1,000 pounds maintenance . . .	0.700	7.925
19.1 pounds milk 5% fat . . .	1.261	7.296
Total	1.961	15.221

These requirements could be met by the following ration:

	COST OF RATION (CENTS)	LBS. DIGESTIBLE PROTEIN	LBS. TOTAL DIGESTIBLE NUTRIENTS
Silage, 30 pounds	7.5	.330	5.310
Alfalfa, 10 pounds	11.0	1.060	5.160
Grain Mixture, 6 pounds . . .	8.1	.709	4.484
Total	27.6	2.099	14.954

The feed cost of a pound of fat produced from such ration in this case is 28.9 cents. Assume now that the cows are fed a ration sufficient for 150 pounds of fat in a year. Such fat production would require 3,000 pounds of milk testing five per cent fat or 8.2 pounds daily. The daily requirement for these cows would be as follows:

	Lbs. Digestible Protein	Total Lbs. Digestible Nutrients
Maintenance, 1,000 pounds	0.700	7.926
8.2 pounds, milk, 5% fat	.541	3.122
Total	1.241	11.148

These requirements could be met by the following ration:

	Cost of Ration (cents)	Lbs. Digestible Protein	Total Lbs. Digestible Nutrients
Silage, 35 pounds	7.5	0.330	5.310
Alfalfa, 9 pounds	9.9	.954	4.644
Grain, 1 pound	1.4	.118	.764
Total	18.8	1.402	10.718

The cost of feeding the animals is reduced from 27.6 to 18.8 cents daily; but on the other hand the cost of a pound of fat is increased from 28.9 to 40.8 cents.

Clearly in this case the more liberal feeding was economical. As a matter of fact, the advantage in favor of the liberal feeding is even greater than is shown by the feed cost of a pound of fat. The total labor and other overhead is not much more when 350 pounds of fat are produced than when the 150 pounds are produced. When the overhead is added to the feed cost of a pound of fat, the difference in favor of the higher production is very marked.

Under anything like normal conditions it is difficult to justify the withholding of grain when the cow has a capacity greatly beyond what she can maintain with roughage alone as a ration. Even if the additional milk will not more than pay for the feed there will be a reduction in the cost per 100 pounds of milk, because the overhead charge will be distributed over a large volume. For example, if it cost $50 in addition to feed to keep a cow a year, this is $.50 a hundred if she produces 10,000 pounds of milk, and $1 a hundred if she produces only 5,000 pounds.

Grain Feeding in Irrigated Alfalfa Districts. An interesting phase of the feeding problem arises in the irrigated regions of western United States. Here alfalfa is grown in large quantities and is very cheap on account of its abundance and distance from market. Grain, on the other hand, is high in price. The milk producer has his choice of feeding alfalfa exclusively or of supplementing with barley or other cereal at a rather high cost.

The question is, should the farmer be satisfied with a production of about 5,500 pounds yearly from a herd of Holstein cows, or should he, by adding a limited amount of grain, secure an additional 2,500 or 3,000 pounds?

So far, even those engaged in experiment station work are not unanimous in their agreement as to the proper course to pursue in such regions. According to Woll, the practice of feeding concentrates of some kind in addition to the alfalfa is increasing—partly to secure a larger production, and partly on account of a belief that continued heavy feeding of alfalfa is detrimental to the breeding qualities of the animals. Woll reports as the result of experiments that the method of feeding grain in the ratio of 1 pound to every 5 pounds of milk yielded within 5 per cent as good results as a ratio of 1 pound of grain to each 3 pounds of milk. His experiments show that an increase of about 25 per cent in milk flow may be expected with good cows when alfalfa is supplemented with a limited grain ration and corn silage.

The following statements aim to summarize the subject as far as the difficulties involved make such a procedure possible:

The capacity of the cow to handle roughage is naturally limited. Under the very best condition, with roughage alone an average production of from 150 to 175 pounds of fat is the maximum that can be expected. If the capacity of the cows for milk production is not greater than can be supplied with the necessary nutrients from roughage it is not economy to feed much grain. Under these conditions the addition of grain results in the animal's depending upon this source of nutrients to a greater extent and using less hay. If the animal has a capacity for milk production beyond what can be obtained from roughage, grain should ordinarily be fed.

In a consideration of this question the importance of the overhead expense should not be overlooked. The ration of maintenance is the same for light as for heavy production and labor and other expenses nearly as great. After going to the expense of maintaining the cow it seems wise economy to make a full use of her producing ability.

The experience of Europe as well as experimental work here indicates that in general a moderate grain ration is more economical than a very heavy grain ration. The rules suggested for feeding, one pound to each three or four of milk according to the richness, if followed will result in economical production under ordinary circumstances.

Unusual conditions may alter the value of such suggestions temporarily or local conditions may be such that their application is questionable.

FEED AND CARE OF THE COW ON OFFICIAL TEST

The maximum production is secured from high-producing cows only by the combination of the expert herdsman and the best possible ration and conditions. Such cows cannot be fed entirely by any rule, nor their ration calculated by a formula. The individual animal and her characteristics must be taken into account as well.

Fitting for Test. Since official records have come to determine very largely the value of pure-bred dairy cows, every means is taken to secure the largest possible production. The experience in making these records has emphasized strongly the importance of having the animal in the best of physical condition at the time of freshening. The preparation of the cow for an official test begins several weeks before the date she is expected to freshen and is known as "fitting."

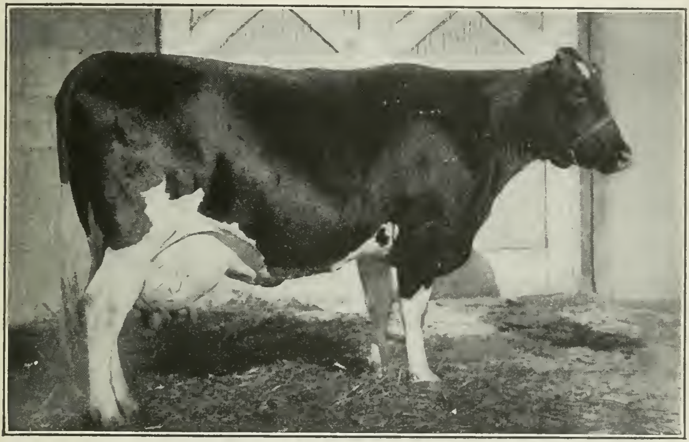


Fig. 79. May Walker Ollie Homestead as she appeared while making the highest American butter fat record, 1,218 pounds in one year. Great records are the result of a combination of a great cow and exceptional care and skill in management.

The cow should be dry for eight weeks at least, and some prefer three or four months for preparation. During this time she is fed a most liberal ration, expecting a liberal gain in weight to be made. In preparation for short-time tests it is especially important to have the animal very fat as the fat percentage in the milk will be much higher as a result. Excessive fattening is not so essential when the animal is to be on test for a year.

The ration should consist of a succulent feed and a grain mixture. If the pasturing season is on, the grass alone serves as roughage. When grass is not available corn silage or roots are necessary. In this case alfalfa or clover hay should be included. Dried beet pulp is a desirable addition to the ration. Three or four pounds, moistened with three times as much water by weight are often fed. The beet pulp assists in keeping the digestive tract in good condition.

The grain ration fed should be palatable, light, and medium in protein. The feeding of the fitting ration continues until within about two weeks of calving, when a ration somewhat more laxative is substituted. A mixture of bran, oats, and oil meal with beet pulp is considered a suitable mixture.

The fitting ration generally contains at least five grains or by-products. Many different combinations are used and no one mixture can be said to be the best. The following are fitting rations used by successful feeders:

RATION 1
100 lbs. wheat bran
100 lbs. ground oats
100 lbs. hominy feed or corn meal
100 lbs. linseed oil meal
Fed with alfalfa hay and silage

RATION 2
100 lbs. wheat bran
100 lbs. ground oats
100 lbs. oil meal
75 lbs. cottonseed meal
50 lbs. corn meal
Fed with silage and alfalfa hay

Rations of which the above are typical are fed at the rate of from 10 to 25 pounds daily, depending upon the size, condition, and appetite of the cow. During the fitting period the cow is generally kept in a box stall with only a little exercise. During the last few days before freshening the ration should be quite laxative, and to insure this some breeders give a warm bran mash once a day. If the bowels are not in a laxative condition as the result of the ration, physic is generally given. After the calf is born, the cow is given some warmed water and often a warm bran mash. Little grain is fed for the first twenty-four hours. The water given should be warmed for the first two or three days.

Getting the Cow on Feed. After about two days the cow is started on a small amount of the regular ration, and if her condition is good the ration can be increased within a few days to the amount she was receiving before freshening. From this point on the judgment of the feeder and the appetite of the cow determines how much she should receive. As a rule, the full ration will not be given until at least three weeks after calving, while some feeders do not reach the point of heaviest feeding for 60 days.

Short-Time Records. The best results from short-time tests are obtained when the cow freshens during cool weather. Experienced breeders seldom undertake to make a 7-day record from May to October. The 7-day test is generally begun as early as the rules permit, because the fat percentage is highest at first and gradually declines. The cows are milked and fed four times daily. The animal is fed as much grain as the animal seems able to handle without injury. From 25 to 30 pounds daily are not unusual amounts for a heavy-producing Holstein cow. It should be understood that a cow cannot be forced to produce milk by heavy feeding alone. If she does not respond to increase in the feed it is time to go very carefully.

As long as the animal remains in normal condition, no change in the grain ration is necessary. Special attention must be given to the physical condition of the cow. In this connection the careful herdsman always observes closely the character of the dung excreted, and learns to judge in this way when the digestion is normal. At the first indication of the lack of a keen appetite the ration is cut down until the animal is in a condition to again utilize the full amount. If the digestion shows indication of even slight disorder, a purgative—such as epsom salts, 1 to 1½ pounds at a dose—should be administered at once. The grain should always be eaten with a relish, and the animal should show a disposition to want a little more than she receives. If the animal refuses even the smallest portion of her grain the observant herdsman notes it at once and reduces the allowance.

Long-Time Tests. Practically the same feeding practices are followed for the long as for the short-test periods, except that the cows are not forced so hard and are not generally fitted to quite the same degree. In all cases, attention has to be given to the likes and dislikes of the cow. Each animal must receive the individual attention of the herdsman and her characteristics understood. The question of good roughages must be emphasized especially in the long-time test.

A good succulent feed such as silage or roots is indispensable. High quality hay, preferably alfalfa, is also necessary. During the pasture season the cow may be turned out to graze during the cool of the day. A soiling crop should be ready for feeding if the pasture becomes short or dry. Provision should be made that an abundance of good water is readily accessible. Hot weather is the most serious disturbing factor when yearly records are being made. Cold weather is not harmful, as animals can be protected sufficiently and do better in a temperature around 40 degrees than when warmer.

Grain Mixtures for Official Testing. A mixture for use by a cow on official test should contain at least five or six grains or by-products representing several different plants. The mixture should be light in character, palatable, and rich in protein. Individual feeders have their favorite mixtures, the special value of which they often overestimate. As a matter of fact there is no reason for believing that any one mixture is any better than many others that could be prepared.

The following mixture is used in feeding cows on official test owned by Cornell University.

200 lbs.	distillers' dried grain
200 lbs.	wheat bran
100 lbs.	gluten feed
100 lbs.	ground oats
200 lbs.	hominy
100 lbs.	linseed oilmeal
12 lbs.	salt
12 lbs.	charcoal

One of the most successful herdsman in Minnesota feeds the following mixture:

600 lbs.	cottonseed meal
500 lbs.	dried brewers' grains
500 lbs.	gluten meal
400 lbs.	corn meal
400 lbs.	wheat bran
400 lbs.	linseed oilmeal

Sliced beets are considered an important addition to the ration, especially for the cow on short-time test. When available in sufficient quantities fifty or even at times one hundred pounds are sometimes fed daily. In long-time test beet pulp largely replaces fresh beets. The dried pulp is wet with warm water several hours before feeding and the grain mixture is usually poured over it in the feed trough or mixed with it if preferred.

CHAPTER XXVIII

CHARACTERISTICS OF COMMON FEEDS

FODDER

Corn Fodder. The term "corn fodder" indicates that the ears are included. Corn fodder is widely used for wintering beef cattle where hogs are on hand to gather up the corn otherwise wasted. For dairy cows kept mostly in the barn, corn fodder is not satisfactory and is used only to a limited extent. It is low in protein and relatively unpalatable outside of the grain contained, but it is equal to timothy hay in total nutrients. A limited amount, up to 5 pounds a head, may be fed to dairy cows. The common plan is to feed it during the day in the open.

Corn Stover. Corn stover is corn fodder from which the ears have been removed. It may be utilized to a limited extent and is generally fed in the open. It is very low in protein, unpalatable, and constipating. The point should not be overlooked however, that its feeding value is not far behind that of timothy hay. The practice of shredding corn fodder has not been found to increase the feeding value of the stover. The advantage of the treatment is that the stalks are shredded and cut, making it possible to feed the shredded stover in the barn and to use the refuse for bedding.

Sorghum Fodder. Fodder from the sorghum plant is sometimes cured in shocks in the same manner as that common for corn. The fodder is eaten fairly well during a period of two months after cutting, but it sours later and becomes decidedly unpalatable. Its feeding value is about the same as that of corn stover.

STRAW

Oat Straw. Oat straw from grain cut rather early will be eaten to a limited extent by dairy cows. It should not be relied upon as part of the ration. Cows turned out of doors during the winter will eat a little straw if fed in the open. It is extremely low in protein, low in total nutrients, and unpalatable. In a well-fed herd its only important use is as bedding.

Wheat Straw. This straw is less valuable than oat straw and is hardly to be counted as a feed at all, but it is excellent bedding material.

Rye Straw. This straw is useful only as bedding. Cattle will not eat it and the digestible nutrients are so low that it would be useless if eaten.

Barley Straw. Barley straw has little feed value and there is danger of the beards penetrating the sides of the mouth and causing trouble.

HAY

Timothy Hay. Timothy hay is widely grown, largely because it does well almost everywhere and is easy to get started. The value of this hay is often greatly overestimated as a feed for dairy cows. It is unpalatable for cows except when cut early and will therefore not be consumed in sufficient quantities. The most serious objection to it is its low protein content, which makes necessary the feeding in large quantities of concentrates rich in this expensive nutrient when timothy hay is fed.

Alfalfa Hay. Properly cured hay from the alfalfa plant would easily be ranked first among all hays by dairy cattle feeders. It is very palatable and laxative in character, it contains a relatively large amount of protein, and it is the highest of all common foodstuffs in calcium. Almost any ration not containing alfalfa is improved by its addition.

Clovers. Clover hay has much the same advantages as alfalfa. It is not quite so palatable, however, and is a little lower in protein. The alsike has practically the same composition as the red but is finer stemmed making it especially well adapted for calf feed.

Soy-Bean Hay. This hay has the same advantages and characteristics as other legumes. It is very palatable, is high in protein and total nutrients, and also supplies a liberal amount of calcium.

Cow-Pea Hay. When properly cured, cow-pea hay is palatable and even superior to clover in protein and total nutrients. It is grown extensively in the southern portion of the United States.

SILAGE

Corn Silage. The importance of supplying a succulent food to the cow at all times has been discussed elsewhere. In feeding corn silage it should be kept in mind that corn silage is not of itself a complete ration for the cow in milk, since it is relatively high in carbohydrates and low in protein. Furthermore it is not advisable to feed it as the only roughness. Some hay should be given as well, and for this purpose the legumes are the best adapted on account of their high protein and ash content. It is not advisable to feed over about 35 pounds of silage to a small cow and 40 to 45 to a large animal.

Kaffir Corn Silage. Kaffir Corn ranks next to corn as a silage crop, being only slightly behind corn in composition and feeding value. It is widely grown in the semi-arid regions.

Sorghum Silage. Common sorghum yields heavily over wide areas and makes a satisfactory silage ranking, however somewhat below corn silage. An important point is to allow the crop to reach the proper stage of maturity—otherwise the silage will contain more acid than is desirable.

Pea and Oat Silage. These crops grown together make good silage if cut at the proper stage—when the oats are starting to turn yellow. The protein content is a little higher than that of corn, but the total nutrients are about the same.

Legume Silage. Alfalfa and clover make a satisfactory silage if put into the silo in the proper condition, as described in another chapter. The protein content of legumes is higher than that of corn, and the total of nutrients may be about the same or higher, depending upon the amount of moisture present. Sweet clover may also be used to advantage for silage. The chief objection to putting crops of this kind into the silo is the labor involved in handling the green material.

Sunflower Silage. The sunflower thrives in regions where the temperature is too low to develop corn. The yield is large and the silage is satisfactory succulent feed. Sunflower silage is not equal to that made from corn in the proper stage of maturity, but it is equal in feeding value to silage made from corn in an immature condition. It is not as palatable as corn silage, although, cows soon learn to eat it and thrive on a ration containing it.

Roots, Tubers, and Pumpkins

Mangels. The mangel is the most widely used root crop. Like other roots it has a high water content (90.6 per cent), but as a means of supplying succulence it is unexcelled. It is highly palatable and should be fed more generally in this country—as it now is in Europe. Forty to 60 pounds a day is a fair allowance.

Rutabagas. This crop has the same advantages as mangels, and practically the same feed value. Like other turnips, there is some danger of the milk's being tainted where it is fed.

Sugar Beets. The sugar beet is not generally grown for feeding, as the yield is lower than for mangels or rutabagas and the labor of raising more. As a palatable succulent feed, sugar beets are highly prized. And because of the high sugar content the feeding value of sugar beets is somewhat more than of mangels or rutabagas.

Beet tops are a valuable feed, and where beets are grown for market the tops should be preserved for feeding. This is best done by putting them in a silo.

Potatoes. Cull potatoes are at times available in sufficient quantities to justify considering their use as feed. The potato contains about double the dry matter content of roots but is not as desirable a feed for the bovine. Potatoes are best fed to swine, but they may be used up to 25 pounds daily for feeding cows. Large amounts have a detrimental effect upon the quality of butter produced and are liable to cause indigestion in the animals.

Pumpkins. Pumpkins are often planted with corn and provide an excellent supplement to the ration for a period in the fall. The feeding value of the pumpkin is not high and they should be looked upon more as a relish than as a main part of the ration. The pumpkin is over 90 per cent water and about 2½ tons, including seeds, are required to equal a ton of corn silage in feeding value. The seeds are sometimes removed when feeding pumpkins through the erroneous idea that they dry up the cows. There is no ground for this belief, as the seeds are rich in feed nutrients and contain no injurious substances.

CONCENTRATES

Corn. Over the greater part of America corn is the most common and the cheapest grain. In the corn belt this valuable grain is often fed to excess. On the other hand, some dairymen avoid feeding it altogether, on account of an erroneous idea that it is not suited to a cow producing milk. Corn may be fed in reasonable quantities to any class of animals on the farm. It is especially palatable for the cow in milk. However, for good results, it must not be exclusive grain ration. The protein content of corn is low, likewise the ash. If combined with corn stover or corn silage for roughness, the protein content is entirely too low for a dairy ration. Corn silage and ground corn combined with clover or alfalfa hay and bran, however, make a good ration for general feeding.

Wheat Bran. Next to corn, wheat bran is the most important cow feed of this country. Its great value as a food for growing animals and cows in milk comes from the high ash and protein content. Its light, loose character also makes it a valuable addition to a heavy ration in the way of lightening up the mass to make it more easily acted upon by the digestive juices. This is of special importance in connection with such feeds as cottonseed meal, that have a tendency to form a pasty mass in the stomach which is difficult to digest.

Wheat Middlings. Wheat middlings, or shorts, are valuable feeds for the cow, but more like corn meal in composition and properties than like bran. As a rule, it is wiser to make use of the bran rather than shorts for the cow in milk.

Oats and Oat Products. Oats are a fine feed for cows and growing animals when the cost is not prohibitive. Woll found oats to be about 10 per cent more valuable pound per pound than bran when fed to cows. In general, it may be said that oats are themselves an excellent ration, but they do not contain sufficient protein to be as effective in supplying a deficiency in that respect as are others with a high protein content. The valuable by-products of oats are mainly from oatmeal mills, and consist of oats shorts and finely divided parts of the grain sifted out. In addition, a much larger quantity of hulls must be disposed of by these mills. Hulls are mostly crude fiber and are hardly equal to the same weight of timothy hay in feeding value. The by-products of the oatmeal mills are therefore valuable to the extent that they contain the parts of the grains. Oat hulls are used largely to form a portion of various mixed feeds that are put upon the market.

Barley. Barley is an important dairy feed in Europe. In America corn, on account of its abundance and cheapness, has taken its place. In composition and feeding value, barley is practically equal pound for pound to corn. It will probably be more generally used in dairy rations in the future, as its decreased use in brewing tends to bring the price nearer to that of corn.

Rye. Rye has a composition not greatly different from corn, but it ranks somewhat below corn in results. It is unpalatable, and when fed in large quantities tends to produce a butter with a hard objectionable body. It can be fed up to 2 or 3 pounds a day by being ground and mixed with other grains.

By-Products

Cottonseed Meal. This by-product is the residue left after the oil is extracted from the cottonseed. It contains the highest amount of protein of any concentrated feed ordinarily found upon the market. For this reason, it is especially valuable as a means of balancing up rations deficient in protein, where corn and corn products form a large proportion of the ration. It should not be fed to excess at any time. As a rule from two to four pounds per day are to be considered the maximum to be used. However, in the South, where it is abundant, it is fed much larger quantities with good results. If it is desired to buy cottonseed meal in large quantities and to store it for some time, especially over summer, it is best to buy it in the cake form or preferably broken into pieces, but not ground. The cakes grind easily and may be ground as needed.

Cold Pressed Cottonseed Cake. This product results from the extraction of the oil from the unhulled cottonseed by pressure applied without heating the material. It therefore includes the entire seed with the exception of the oil. It is much higher in fiber than cottonseed meal on account of its containing the hulls, together with some cotton lint that adheres to the seed. It is lower in protein than cottonseed meal and consequently less valuable as a feed. It is usually sold in the cake form.

Linseed Meal. This valuable feed is the residue after the linseed oil is extracted from flaxseed. It ranks next to cottonseed meal in protein, but on the market it usually sells a little higher. It seems to have a specially favorable effect upon all kinds of animals to which it is fed. Like cottonseed meal, it is especially valuable as a means of supplying the protein liable to be lacking in the farm-grown ration. It is somewhat laxative in character.

Gluten Meal. This is a by-product of starch and glucose manufacture. The bran or outer layer of the corn, the germ, and most of the starch are removed in the process of manufacture leaving a residue which is mostly the protein of the kernel. Gluten meal ranks high in digestible protein, but it is a heavy, rather unpalatable feed and should always be fed in a mixture with other feeds of a more bulky character. The protein content varies considerably and the guaranteed analysis of the meal should always be taken into account when it is bought.

Gluten Feed. Gluten feed or corn gluten feed is gluten meal with the corn bran added. It is high in protein, although lower than gluten meal, and on account of the bran it is bulkier and safer to feed. It is fed more generally than the gluten meal and in fact, in recent years little gluten meal is on the market, the greater part of it being sold as gluten feed. Gluten feed is a valuable, and at times an economical, source of protein, but it is not advisable to use either gluten feed or gluten meal as the sole supplement to a corn ration.

Brewers' Grains. Fresh brewers' grains are fed in large quantities, where they may be hauled directly from the brewery. Considerable objection has been raised by city health authorities in many places to the use of this feed. If fed in moderate amounts under proper sanitary conditions, they are not objectionable. However, the use of them is so often abused that some officials have found it easier to prohibit than to regulate it. The objection comes from their being fed exclusively, their being allowed to begin decomposing before they are fed, and from the very objectionable sanitary condition that exists if special care is not taken to keep the feed boxes, feeding troughs—in fact, the entire stable—clean. This feed should not be used to exceed 20 pounds per day, and it should be supplemented with hay and some other grain, such as corn.

The greater part of the brewers' grains are dried, and in this form are a valuable feed. This feed is bulky and palatable. In composition it shows a digestible protein content of 21.5 per cent —more than twice that of oats—with a content of total nutrients slightly below that of oats.

Distillers' Grains. Distillers' grains are by-products of the manufacture of alcohol and distilled liquors from corn, rye, and, at times, some mixture of rice and other cereals. This feed ranks with gluten meal in protein content. Like the other by-products of this class, it varies greatly in protein and the buyer should take as a guide the guaranteed analysis. Distillers' grains are rather unpalatable, but they are eaten without trouble when fed in a mixture with other feeds. The advisability of making use of this class of feed will depend mostly upon the market value.

Dried Beet Pulp. Since the beet sugar industry has become of some importance in the United States, the by-products are found on the market for cattle feed. The beet pulp from the factory contains only about 10 per cent of dry matter. On account of its bulk it cannot be transported any distance, and it is fed only in the immediate neighborhood of the factory. Most of the beet pulp is placed on the market in the dried condition, in which form it is meeting with considerable favor as a feed. Its composition is high in carbohydrates in proportion to the protein, ranking in this respect below corn. In feeding it should be combined with other feeds richer in protein. It swells when moistened, and cannot be pressed into a compact mass. For this reason it is easy to digest and valuable to lighten up a grain ration that otherwise would form a mass in the stomach not easily penetrated by the digestive juices. It is especially useful in feeding cows for the maximum production, as under official test conditions. The dried beet pulp is usually moistened with about three times its weight of warm water, several hours before feeding. The grain mixture is either mixed with it or spread over it in the feed box.

MOLASSES AND MIXED FEEDS

Molasses. Another by-product of the cane and beet sugar factories is the low grade molasses often known as "black strap." Black strap has about 65 per cent of the feeding value of corn, pound for pound. It is practically a pure carbohydrate mixed with a certain amount of mineral matter. Molasses serves a useful purpose as a means of making unpalatable feeds more readily consumed. Unfortunately, on account of its palatability it is too often used to cover up inferior quality in a mixed feed or to disguise materials of little feeding value. Molasses serves a useful purpose as an appetizer for animals receiving a heavy ration and is used by many feeders of cows on official test. As a source of digestible nutrients it is usually too expensive for general feeding.

Mixed Feeds. No small proportion of the grain fed the dairy cows of the United States is in the form of mixed feeds. In the past, mixed feeds have been in bad repute because of the common practice by unscrupulous manufacturers of using this means to dispose of inferior or worthless products. As a result of this condition, laws are now in force in most of the states where considerable quantities of mixed feeds are sold which require the labeling of each sack with a guaranteed analysis. Some provision is made for inspection by state authorities to insure the feed's being as represented by the label. Many reliable companies are now engaged in the business of preparing mixed feeds. By patronizing firms of known repute and paying proper attention to the guaranteed analysis, the buyer may use feeds of this class with advantage. When honestly prepared, they serve a useful purpose as a means of utilizing by-products to advantage—malt sprouts, for example—which cannot be fed to advantage alone. Where only a few cows are to be fed, it is often impracticable to have several kinds of feeds on hand from which to prepare a mixture, or often the kinds needed are not for sale locally. The feeder may be uncertain as to a proper combination. Under these conditions a mixed feed serves the purpose to advantage, making it possible to supply the necessary variety and at the same time to purchase limited quantities at a time. When large quantities of feed are purchased there is seldom little advantage in buying it in mixed form. The person who has the responsibility for the feeding of the herd under these conditions should have the knowledge necessary to prepare a suitable mixture; and unmixed grains and by-products are usually cheaper sources of nutrients than the mixed feeds.

Under present conditions the former objection of inferior quality in mixed feeds has largely disappeared. The main question that is now being raised is that of economy. The retail price of mixed feeds generally includes more transportation charges than are necessary on unmixed grains or by-products. The ingredients may be shipped from several states to the point where the mixing is done. The mixed feed is often shipped back to the same region from which the products included came originally, making a second freight charge necessary. As a rule, the retailer also receives a larger margin of profit on the mixed feeds that sell under a special brand.

Unlike unmixed grains which need no advertising the expenditure of large sums is necessary in order to familiarize the public with a particular brand. This expense is necessarily added to the selling price.

Buying Feed by Analysis

As already mentioned, nearly all states in which large quantities of feed are purchased by the farmers now have some law in force regarding the sale of feeding stuffs. These laws, however, do not take the place of intelligence on the part of the feed users. Such laws generally require the proper branding and labeling of each sack to indicate the chemical composition. It should be remembered that the label gives the total amount of protein and other constituents, not the amount that is digestible which will be decidedly lower. Every feed buyer should patronize only reliable dealers, and buy feeds that are labeled and guaranteed. There are no mixtures better than the buyer can make himself, and there is no special feed or mixture having any remarkable properties not possessed by familiar feeds. The buyer of mill feeds should make a point of keeping in touch with the experiment station of his state—and if the feed control is vested in some other body or official, with them as well—and make use of the information they will be able to furnish regarding the feeds on the market.

Alfalfa-Molasses Feeds

In recent years a large number of feeds have been placed on the market which are chiefly ground alfalfa and black strap molasses. In some cases a small amount of ground grains or by-products are also included. These feeds, when put out by reliable firms insuring a good quality of alfalfa meal and other ingredients, are a useful addition to the available feedstuffs. Cattle eat such feeds with great relish, and the results are satisfactory. The chief objection is that the price at which feeds for this class are sold is usually such that they cannot be used with economy. Adding a small quantity of molasses to hay does not justify prices equal to those of grains. Unfortunately, many preparations of this kind, in addition to being an expensive source of feed nutrients, are made from alfalfa meal of such inferior quality that animals would not eat it at all were it fed without molasses. In some cases damaged hay, or even alfalfa straw, is used, and damaged grains, mill sweepings, or oat hulls from an oatmeal factory are added to give the appearance of grains in the feed.

Stock Foods

Through the force of advertising, the farmers of the country have been led to spend millions of dollars for foods of this kind. Stock goods or condition powders usually consist of a mixture of common feeds such as linseed meal, wheat middlings with some common substances, such as common salt, charcoal, epsom salts, ginger, gentian, and copperas. These are generally harmless, but are worth no more to the animal than an equal amount of ordinary feed. Some have been found to contain as high as 70 per cent of common salt. The stockman should not waste his money by investing in this class of feeds. If his animals are in good condition they need no tonics; if sick, they need specific treatment adapted to their condition, not a cure-all in the form of a mixture of substances unknown to the user.

CHAPTER XXIX

THE FEEDING STANDARD AND THE CALCULATION OF RATIONS

The Requirements of an Animal. A dairy cow uses feed for the following purposes:

1. For maintaining the body.
2. To supply material for milk.
3. For development of the fetus.
4. For growth in case the animal is immature.
5. At times to produce gain in weight.

For each of these purposes three general classes of food material are required :

1. Protein or nitrogenous material.
2. Carbohydrates and fat to supply the heat and energy.
3. Ash or mineral matter.

In addition certain vitamines are needed, but as yet the information available concerning the vitamine requirement for cattle is exceedingly limited. The main problem of feeding is to supply the proper amount of the food material of the three classes in the least expensive form. It is evident that the first step is to know what the animal requires for food and how to prepare a ration that will meet this demand.

Composition of Feeds. When a chemist makes an analysis of any foodstuff—clover hay, for example—he determines the amount of water, protein, ash, crude fiber, nitrogen free extract, and fat contained in the substance.

Water. All feeds—even those apparently dry, like corn or hay—contain a portion of water varying from 10 to 15 per cent with this class. Roots, such as beets and turnips, contain approximately 90 per cent of water. The water in the feed serves the same purpose as ordinary water consumed by the animals.

Ash. This is the mineral part of the plant substance remaining after the material is burned. It makes up the greater part of the bones, and is a necessary part of every ration.

Protein. This important constituent is known by the fact that it contains nitrogen. It serves the purpose of building up tissue in the body—such as muscle, skin, etc.—and constitutes the curd of milk. Lean meat and the white of an egg are familiar examples of nearly pure protein. All feeds contain more or less protein. Among the hays clover, alfalfa, cow-pea, or soy-bean contain the largest amount. Among the common concentrates linseed meal, cottonseed meal, and wheat bran contain relatively large quantities. A certain amount of protein is indispensable in a ration, as nothing else can be substituted for it by the animal.

Crude Fiber. This is the woody part of the plant, which is the least digestible. The amount of this constituent increases with the age of the plant, and is large in feeds like hays and corn stover, and small in concentrates like corn and linseed meal.

Nitrogen Free Extract. This is a term given to a class of substances much like the crude fiber in composition, but which are much more easily digestible. The greater part of this group is composed of starch.

Fat or Ether Extract. That part of the feed stuff which will dissolve out in ether is called an "ether extract." It consists mostly of fats, but contains sufficient other products to make it somewhat inaccurate to call this group fat—although this term is often used.

The crude fiber, nitrogen free extract, and fat all serve much the same purpose in the body. They supply heat to keep the body warm, material to be built into fat and to be burned or oxidized in the body to furnish energy. All foodstuffs contain these same constituents, but in widely varying quantities.

Digestibility. However, the animal is not able to digest all of the substances in any feed stuff. The proportion of the protein, for example, that may be used depends largely upon the nature of the feed under consideration, the grains being more thoroughly digested than the hays. The amount of each of the substances given that can be digested from any feed stuff by the animal is determined by what are termed digestion trials. The chemist makes such a trial by analyzing the food consumed during a certain period by an animal, and at the same time collecting all the dung excreted and analyzing that to find out how much passes through the alimentary canal. The difference between the amount consumed and the amount voided is called digestible. Such tests have been made of all common feeding stuffs, so the practical feeder has data at hand regarding both the composition of feeds and their digestibility to serve as a guide in preparing suitable ration.

The Feeding Standard. Numerous chemical analyses have been made of all common feed stuffs. These data show how much of the several constituents will be supplied by feeds of average composition. It is known that the animal needs all of these constituents. The question is, how much is needed for a particular purpose, as for growth by the immature animal or for milk production by the cow? This problem has received the attention of numerous investigators for nearly half a century. The conclusions from such investigations in the form of a statement setting forth the needs of an animal in the way of nutrients for a certain purpose is called a feeding standard.

The history of the development of feeding standards is a long one and will not be given. The standard published originally by Wolff, and later known in the revised form as the Wolff-Lehman, has been widely used. In this standard the requirements of the animal and the nutritive value of feeds are given in terms of digestible protein, digestible carbohydrates, and digestible fat or ether extract. The carbohydrates include the crude fiber and the nitrogen free extract.

The standard formulated by Haecker has been widely used in America. The feed requirements in this standard are expressed in the same terms as the Wolff-Lehman. It is a decided step in advance, however, in so far as provision is first made for the maintenance of the animal and then an allowance added according to both the amount and the richness of the milk produced.

Kellner in Europe and Armsby in the United States materially advanced the fundamental knowledge of nutrition. Armsby also formulated a feeding standard based upon his investigations. In his system the requirements of the animal and the value of the feeds are expressed in terms of protein and net energy. The term "net energy" represents the heat-producing value of the feed which the animal can actually use. The Armsby method gives the most exact statement of feed values so far as the carbohydrates and fats are concerned. His view that only complete proteins are used by the animal is not generally accepted and stands in the way of a more general use of his feeding standard.

More recently, Morrison has suggested a standard which he describes as a modification of the Wolff-Lehman. This standard makes use of the most valuable features of the Wolff-Lehman and the Haecker standards and also embodies some further improvements. Morrison, in speaking of this standard, says, "These recommendations are presented not as final arbitrary standards but as approximations based on the older standards, on the data of recent experimental trials, and on rations which have given excellent results in practice."

In this standard the requirements are given in terms of "digestible crude protein" and "total digestible nutrients." The total digestible nutrients is the sum of the digestible protein, the digestible carbohydrates, and the digestible fat multiplied by the factor 2.25. The factor 2.25 used to convert the fat into its equivalent carbohydrate value. The requirement for the cow is divided into two parts, that used for maintenance, and that necessary for milk production, taking into account the amount and richness of the milk. Table 63 gives the Morrison Standard.

TABLE 63. MORRISON FEEDING STANDARD FOR MILK PRODUCTION[1]

	DIGESTIBLE CRUDE PROTEIN	TOTAL DIGESTIBLE NUTRIENTS
	LBS.	LBS.
For maintenance of 1,000-lb. cow .	0.700	7.925
To allowance for maintenance add:		
For each lb. of 2.5 per ct. milk . .	0.045–0.053	0.230–0.256
For each lb. of 3.0 per ct. milk . .	0.047–0.057	0.257–0.286
For each lb. of 3.5 per ct. milk . .	0.049–0.061	0.284–0.316
For each lb. of 4.0 per ct. milk . .	0.054–0.065	0.311–0.346
For each lb. of 4.5 per ct. milk . .	0.057–0.069	0.338–0.376
For each lb. of 5.0 per ct. milk . .	0.060–0.073	0.362–0.402
For each lb. of 5.5 per ct. milk . .	0.064–0.077	0.385–0.428
For each lb. of 6.0 per ct. milk . .	0.067–0.081	0.409–0.454
For each lb. of 6.5 per ct. milk . .	0.072–0.085	0.434–0.482
For each lb. of 7.0 per ct. milk . .	0.074–0.089	0.454–0.505

[1] Feeds and Feeding. P. 746, 18 ed. (1823.)

Calculating a Ration. The use of the feeding standards is best illustrated by examples such as are met in practical feeding. Assume that a Holstein cow weighing 1,250 pounds and producing 40 pounds of milk daily, testing 3.5 per cent of fat. The requirements for this cow according to the Morrison standard as given in Table 63 are as follows:

	DIGESTIBLE PROTEIN LBS.	TOTAL DIGESTIBLE NUTRIENTS LBS.
Maintenance 1,250 lbs.	0.875	9.90
Milk, 40 lbs., 3.5 per cent fat	2.200	12.00
Total	3.075	21.90

In obtaining these figures the first step is to calculate the maintenance. Table 63 gives the figures for a 1,000-pound animal. The amount needed for a 1,250-pound cow may be calculated by proportion or by finding the amount required for a hundred pounds and multiplying this by 12.5. The nutrients needed for one pound of milk with 3.5 per cent of fat is found from the same table, and the amount calculated for 40 pounds.

The next question is to find a ration that supplies the nutrients as needed according to the calculations made. In calculating the ration the suggestions previously made concerning the use of a succulent feed, and a legume hay will be followed in selecting the roughage. A cow when fed all the corn silage and alfalfa hay she will eat takes 30 to 40 pounds of silage daily, depending upon her size, and from 10 to 12 pounds of hay to the 1,000 pounds of weight. The practical rule of allowing 1 pound of grain to 4 pounds of milk produced by a Holstein cow will be followed in making the first calculation.

PROPOSED RATION	LBS.	DIGESTIBLE PROTEIN LBS.	TOTAL DIGESTIBLE NUTRIENTS LBS.
Corn silage	40	0.440	7.08
Alfalfa hay	12	1.166	5.68
Corn	4	0.276	3.35
Oats	4	0.376	2.80
Oil meal	2	0.604	1.56
Total		2.86	20.47

This ration is a little low in both protein and total digestible nutrients. The addition of a pound and a half of corn to the ration would bring the total to 2.96 pounds of protein and 21.72 pounds of total nutrients.

Deficiencies of a Ration Shown by the Feeding Standard. One of the most effective means of showing deficiencies in rations, as fed under practical conditions, is to calculate what the cow is receiving and how near the ration comes to meeting the requirements, or how much milk she could produce from the ration received, and what the limiting factor is.

For example, in the corn belt states where dairying is not a specialized industry, a common ration is corn fodder, timothy hay, corn, and oats. Assuming that a ration of this kind is fed a Guernsey cow weighing 1,000 pounds, how much milk is it possible for her to produce and what is the limiting factor?

On account of the unpalatable nature of the roughage, even under the best conditions a cow will not eat over 10 pounds each of the timothy hay and corn fodder. We will assume that the animal also receives 8 pounds of a mixture of equal parts corn and oats. This ration would supply the following:

	Lbs.	Digestible Protein Lbs.	Total Digestible Nutrients Lbs.
Corn fodder	10	0.630	5.37
Timothy hay	10	0.630	4.85
Corn	4	0.276	3.35
Oats	4	0.376	2.80
Total		1.252	16.37

A 1,000-pound cow would require for maintenance 0.7 pounds protein and 7.93 pounds total nutrients.

The situation regarding the nutrients received by the cow is as follows:

	Digestible Protein	Total Digestible Nutrients
Received in ration	1.252	16.37
Maintenance, 1,000 lbs.	0.70	7.92
Available for milk	0.552	8.45

According to the standard, milk with 5 per cent of fat requires 0.066 pounds of protein and 0.382 pounds of total nutrients for each pound produced. The protein available in the ration given is sufficient for 8.2 pounds. It is clear that no cow receiving a ration of this kind can be condemned for not producing a liberal flow of milk. While this ration is open to criticism on several points, the most serious is its great deficiency in protein. This could be greatly improved by the substitution of 2 pounds of linseed oil meal for the same amount of either corn or oats.

Value of Feeding Standards. The feeding standard may serve an important place as a general guide for the selection of rations. When the use of the standard is fully understood, occasional calculations will generally be made—for example, when making plans for the winter feeding. Practical feeders who make use of feeding standards do not undertake to calculate rations for each cow, but for typical animals using their judgment in varying the ration for the others.

However, few practical feeders really make use of feeding standards, although through experience and knowledge gathered from reading, their plan of feeding may meet reasonably well the requirements according to the standards. Even extension specialists and county agents in rendering assistance to the owners of dairy herds seldom find it practicable to use the feeding standards in undertaking to improve the feeding systems found in use. The student, however, should master the subject, and the knowledge gained will at least serve as a basis for a sound understanding of the subject.

In addition to the difficulty experienced in working out the details of a ration, several other facts tend to give the feeding standard a less prominent position than it once occupied. One thing is, that it is at times not economical to follow the feeding standard. For example, an abundance of home-grown corn and oats may be on hand and cheap in price, while high protein concentrates like linseed meal are unusually high in price. A farm-grown ration with corn and oats supplying the grain will be too low in protein if the proper amount of total nutrients is fed. In such a case the economical thing to do at times is to feed more total nutrients than are really needed in order to get enough protein without the necessity of buying the high priced concentrates.

In certain regions the reverse condition exists, and the ration available supplied too much protein in proportion to the total nutrients needed. Frequently it is economy under these conditions to over-feed in protein in order to supply the necessary total nutrients.

Again, the feeding standard does not recognize the importance of succulence in the ration. In calculating a ration, a pound of digestible nutrients in timothy hay is as valuable as the same quantity in corn silage or fresh grass. Experience shows decidedly that such is not the case and that a dairy cow will not do her best without a succulent feed.

The feeding standard takes no account of palatability. Coarse or rain-bleached hay, having practically the same chemical composition as hay of good quality, would be ranked the same in value in such a calculation. Experience shows there is a wide variation in feeding value in a case of this kind.

The great importance of supplying an adequate amount of mineral is now recognized. It is certain that at times high-producing dairy cows either suffer for the lack of calcium or phosphorus, or are dangerously close to the line. The feeding standard and the plan of valuing feed according to protein and total digestible nutrients takes no account of the mineral content.

Again it has been found in recent years that the quality as well as the quantity of the proteins is important. The feeding standards and the methods of valuing feed stuffs used in their application does not take this important fact into account.

Investigations in animal nutrition in the last decade have revealed the fact that substances known as vitamines are also indispensable for the growth and well-being of animals. Up to the present, four vitamines have been discovered—all of which have important functions in the body. The knowledge of these substances has been mostly obtained from experiments with small animals, such as rats and guinea pigs, and so far practically no investigations have been made regarding the requirements of cattle for these substances. It is quite certain, however, that the bovine also requires these vitamines. The feeding standard and the method of valuing feed used in this connection does not include these substances.

Determining the Cost of Nutrients. When feed is to be purchased the question at once arises as to which of those available supplies the most for the cost price. A farmer having clover hay, corn silage and corn on hand, for example, realizes that a high protein concentrate is needed—otherwise the protein will be too low. Again it may be a question involving the purchase of the entire grain ration and total nutrients as well as protein. As pointed out, the animal needs a certain amount of total nutrients, included in which must be enough protein to meet the needs. It is clearly impossible to express the value of a certain feed in a single term since high protein feeds also supply other digestible nutrients as well, and feed low in protein—like corn—used primarily for their total nutrients, also supply some protein. For these reasons it should be clearly understood that considerable judgment has to be exercised in interpreting the results.

However, information of value in deciding which feed is to be purchased can be obtained by calculating the cost of a pound of digestible protein, or of total nutrients from the cost of the feed and the composition. For example, if the buyer needs protein to supplement this home-grown ration, it is easy to determine in which of the feeds offered it may be obtained the cheapest.

Suppose that wheat bran may be obtained at $25 a ton, linseed meal at $50, and cottonseed meal at $45. Which is the cheapest source of protein. A calculation should be made as given below:

	Price per 100 Lbs.	Digestible Protein in 100 Lbs.	Cost of 1 Lb. Protein
		Lbs.	Cts.
Bran	$1.25	12.5	10.00
Linseed meal	2.50	30.2	8.20
Cottonseed meal	2.25	37.0	6.08

The figures show that at the prices given cottonseed meal is the cheapest source of protein, and bran the most expensive. Such figures must be used with judgment and other facts of importance must not be overlooked. Bran, for example, has a value outside its protein content in giving the ration lightness. For this reason alone, if corn was the only grain on hand, it would be wise to buy some bran regardless of its higher cost.

The same procedure may be used to show which feed supplies total digestible nutrients at the least cost. For example, corn is worth 56 cents a bushel, oats 45 and barley 60 cents, and the question is which furnishes the most for the price. The calculation would be as follows:

	Price per 100 Lbs.	Digestible Nutrients in 100 Lbs.	Cost of 1 Lb. Digestible Nutrients
		Lbs.	Cts.
Corn	$1.00	85.7	1.17
Oats	1.41	70.0	2.01
Barley	1.25	79.4	1.57

This calculation shows a pound of digestible nutrients can be purchased at the least expense in the form of corn.

The Balanced Ration. The term balanced ration has been widely used in connection with feeding standards. So used, it refers to a proper proportion, or balance, between the protein on one side and the carbohydrates and fat on the other. Along with this usage came the term "nutritive ratio." The nutritive ratio is found by adding together the digestible carbohydrates and the fat multiplied by 2.25, and then dividing the sum by the digestible protein. The result is expressed as a ratio in which the protein is 1. The nutritive ratio of corn, for example, is 1 to 10.4.

These terms are not as generally used as formerly. The view now is that to supply enough total nutrients, of which a proper amount must be protein, is the important thing. The term "balanced ration" conveys the idea not of total quantity but of balance between the total classes of nutrients and that an excess of either is as much to be avoided as a deficiency. Practical feeders often use the term in a more restricted sense, speaking of a ration as balanced when the idea to be conveyed is merely that it supplies sufficient protein.

CHAPTER XXX

THE SILO AND SILAGE

History. The practice of preserving feed in an air-tight receptacle is by no means new. As far back as the Roman Empire, grain and green feed were preserved in underground pits making use of the same principle as that used in preserving silage in the modern silo. As early as 1780, green feed for cattle was preserved in pits and casks in Italy. The first published account of preserving corn by means of a silo dates back to 1869. The first book on silage was written by Goffart, in France, in 1877. The first silo in America was built by Miles, in Michigan, in 1875. About the same time Morris, of Maryland, attracted attention by reporting his experiments along the same line. The first silos used in America were square structures usually built in the barn. The round silo came into use as the result of the very important work of King, of Wisconsin, the results of which were published from 1892 to 1895. In 1882, less than 100 silos were in use in America. Some interest in silos was aroused between 1885 and 1895 as the result of experimental work. The interest however, was not general on account of the cheapness of feed and the inefficiency of the square type of silo used. It is estimated that about three quarters of a million are now in use.

Advantages of the Silo. There are a number of advantages that go with the use of the silo, but the greatest of all is the possibility it affords of utilizing all the crop. This is especially true of corn, which is the main crop used for silage. When corn is husked in the ordinary way and the fodder left in the field from 60 to 70 per cent of the food value of the the corn crop is taken with the ears. While from 30 to 40 per cent remains with the fodder. When the silo is used, all the feeding value goes into the silo and the loss in feeding value is about 8 per cent, leaving 92 per cent of the feeding value of the crop as it stood in the field.

The amount of this saving is easily understood by making comparisons with timothy hay. A ton of timothy hay contains 940 pounds of digestible nutrients. If an acre of corn yielding 50 bushels is put into the silo, an additional 854 pounds of nutrients is saved above the value of the grain. This additional saving would be equivalent to 1,820 pounds of timothy hay an acre. At $10 a ton for hay, the nutrients saved by the silo would be equal to $9.10 an acre.

Saving of room. Another distinct advantage of the silo is the large amount of feed that can be stored in a given space. A ton of silage can be stored in 50 cubic feet of space, while a ton of hay requires 400 cubic feet.

Saving of labor. As compared to cutting and shocking corn in the field, the use of the silo is a distinct saving of labor. When cutting corn for the silo it is handled but once, and that under favorable conditions.

Succulent feed. Silage feeding is the most practical means of supplying feed of a succulent character which is a necessary part of the ration for satisfactory milk production.

Losses in the silo. There are two kinds of losses in the silo: (1) the unavoidable loss due to fermentation of the silage material itself and (2) the avoidable, mostly losses from molding. Under proper conditions the loss in feeding value ranges from 5 to 10 per cent. The corn grain loses about 2 per cent in feeding value in the silo which is less than for corn stored in a crib.

Losses in field-curing of corn. The loss in feeding value of corn shocked in the field is not great during the first four weeks but before spring it becomes serious. The following results were obtained by the author in a comparison of losses in the field and in the silo.

	No. Days	Per cent Dry Matter Lost
In silo	82	3.05
In field	82	4.43
In field	134	43.30

Armsby reported a loss of 21 per cent in the feeding value of corn shocked in the field. Not only is the loss in dry matter much greater in the field, but a considerable portion of the fodder is not eaten on account of its unpalatability. Henry reported that from 14 to 34 per cent of fodder was wasted and the author found from 20 to 32 per cent was refused when fed under the best of conditions to well-fed animals.

Fermentations in silage. Fermentation begins in silage almost as soon as it is placed in the silo. The temperature rises 8 or 10 degrees, and acid and some alcohol is formed. The acid is about two-thirds acetic and one-third lactic. The amount of acid formed depends upon the sugar present, and the amount of sugar in turn, depends upon the stage of maturity of the corn when it is cut. As the corn matures, the sugar is converted into starch. The sugar in the corn at the time of cutting is all converted into acid. The adding of extra water has no influence upon the acidity of silage. Experiments show that the temperature in the mass of silage rises only 8 or 10 degrees from its temperature when put into the silo. The only high temperature is found on the surface, where it may reach 130 degrees F.

The normal fermentation of silage was first attributed to bacteria; later investigators concluded it was the result of enzymes in the live plant cells. The present view is that the fermentation is a combination of the two factors. The heat which develops on the surface and in silage thrown out of the silo but not used for some hours is mainly the result of the growth of yeast.

Construction of the Silo

Size of Silo to Build. A silo can be used to advantage where ten or more cows are to be fed. The size of the silo to use will depend upon the number of animals to be fed. A common mistake is to build a silo with too great a diameter. At least 2 inches a day should be fed off from the entire surface to insure that the silage will not spoil. The height of the silo should be at least twice its diameter. As a rule it is not advisable to build one over 16 feet in diameter, since more labor is required to throw silage from one of greater diameter. If more room is needed, it is better to build additional silos. A fair allowance is from 35 to 40 pounds a day for a mature animal. Thirty-five pounds daily will require 1,050 pounds monthly, or a little over 3 tons to feed each animal 6 months.

Table 64 gives the proper relation between the size of the herd and the capacity of the silo needed:

Table 64. Relation of Size of Silo to Length of Feeding Period and Size of Herd

No. of Cows in Herd	Feed for 180 Days			Feed for 240 Days		
	Estimated Tonnage of Silage Consumed	Size of Silo		Estimated Tonnage of Silage Consumed	Size of Silo	
		Diameter	Height		Diameter	Height
	Tons	Feet	Feet	Tons	Feet	Feet
10	36	10	30	48	10	34
12	43	10	34	57	10	40
15	54	12	32	72	12	36
20	72	14	32	96	12	40
25	90	14	36	120	14	40
30	108	16	32	144	16	40
35	126	16	36	168	14	34
40	144	16	40	192	14	36
45	162*	14	36	216	16	34
50	180*	14	38	240	16	40

*Where this much silage is used, two silos are recommended of the sizes given.

Essentials of Silo Construction. The essential things in silo construction are: (1) an air-tight wall, smooth on the inside so the silage can settle properly, and (2) a structure sufficiently strong to withstand the pressure of the silage and durable enough that it will not have to be replaced for some time. The material used in the construction of the silo has no influence upon the feeding value of the silage, provided it meets the requirements prescribed. The type of construction also has very little relation to the temperature of the silage or to its freezing. The silo should have a concrete floor, and no drain is necessary.

The Wooden Stave Silo. The most widely used silo is the wooden stave. It is placed on a foundation of concrete. Little positive evidence is available as to which wood is the most suitable and durable for silo building. The following statement is supplied by the U. S. Bureau of Forestry:

SPECIES	AVERAGE NUMBER OF YEARS OF LIFE UNTREATED
Cypress	14
Redwood	14
Douglas fir	10
Yellow pine	8
White pine	8

Treatment of the staves with creosote materially increases the durability of the staves. The stave silo preserves the silage as well as any type. It is easily erected and may be taken down if desired. The disadvantages are that it gives some trouble by drying out and attention must be given to keeping the hoops at the right tension. A stave silo should be expected to last from 10 to 15 years, depending upon the kind of wood used.

The Concrete Silo. The concrete silo may be built of block or with solid walls. Of the two, the solid wall, or monolithic, is the more satisfactory. The advantages of the concrete silo are, that when once properly built it is a permanent structure and that it is not damaged by fire, wind, or drying out. If the concrete is properly constructed so that the air is kept out, the silage will be preserved in perfect condition. In case the wall seems porous, a mixture of cement and water of the thickness of whitewash should be applied on the inside each year before filling.

The Tile Silo. This type of silo has become popular in recent years. It has the same advantages as concrete in regard to durability. It preserves the silage equally as well as other types do. It should receive consideration by the man who desires to build a permanent structure but is not located where material for concrete is close at hand.

The Pit Silo. Pit silos are common in the plains regions of the United States. The low price of construction, the remoteness of many farms from the railroad, and the climatic conditions encourage the use of this type. Furthermore, the conditions of the soil in these regions are favorable. A pit silo should never be put in a region with a liberal rainfall. The soil where it is located must be firm, dry, and well drained. A curb of cement is built to extend a few inches above the ground. The walls must be absolutely perpendicular and smooth, and should be plastered with cement.

Other Types of Construction. A number of other materials used less frequently include iron, brick, stone, and wood with a cement lining. Any of these materials may be used satisfactorily under proper conditions.

Crops for the Silo

Corn. The silo has been tried as a means of preserving all the common crops grown on the farm. Corn, however, is preeminently the crop for the silo. The yield of total nutrients per acre with this crop is greater than that ordinarily secured from any other. It has the further advantage of packing well and containing sufficient sugar to form the acid needed to preserve it properly. In the Northern States, larger yields may be obtained from some of the special silage varieties, but these produce a lower amount of grain, and it is questionable if the total nutrients obtained exceed those from varieties grown for grain.

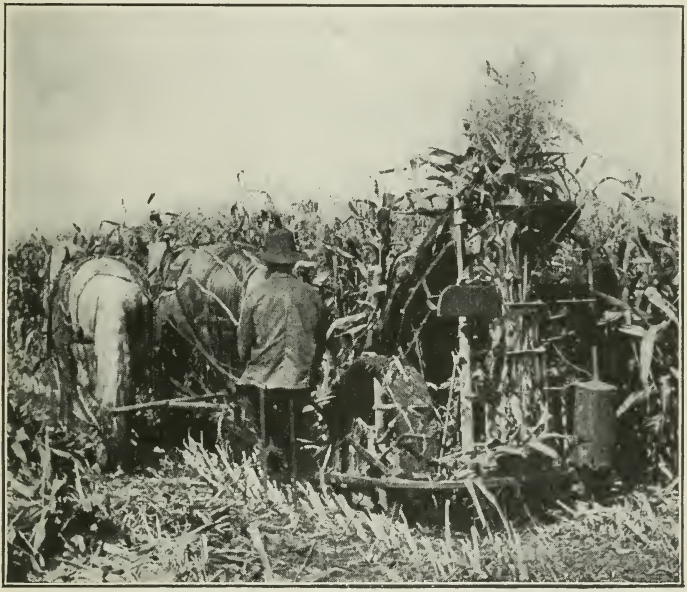


FIG. 80. Cutting corn with a corn binder. The corn binder replaces three or four men in cutting corn. A machine is now on the market which not only cuts the standing corn but performs the service of a silage cutter delivering the cut forage into wagons driven beside the machine. The cut forage is elevated into the silo by a blower or chain elevator.

Kaffir Corn. This crop stands next to corn in quality of silage. It is in use successfully in those sections where small rainfall makes it a safer crop than corn. The feeding value of this silage is only slightly below that of corn.

Sorghum for Silage. This crop stands close to Kaffir in value for silage. Almost as much feed per acre is obtained as with corn, and the quality of the silage is good. Sorghum should be well matured when put into the silo. As a rule, it is not ready to cut until about two weeks after the corn is cut. The seed should be hard, but the stalk filled with juice. If put in too early, a strongly acid silage results.

Legumes for Silage. Legumes, including alfalfa, clover, soy-beans, and cowpeas, are best preserved in the form of hay when conditions make it possible. Soy-beans and cowpeas are ready to go into the silo at the same time as corn and may be mixed with corn to advantage. One load to three of corn makes an excellent quality of silage.

Good silage may be made from the legumes, provided they do not contain too much water. If the legumes are put into the silo when they contain as much moisture as usual in alfalfa cut for hay, the resulting silage will be so strong in odor and taste as to be practically worthless. If the conditions are such that the crop can stand until in the same stage of maturity as corn at time of siloing, good silage will result. This is impossible with any hay crops except peas and oats. Fortunately, the same results may be obtained by allowing the freshly cut material to lie in the sun for a few hours until wilted, but not dry. The proper stage is about one-third the way between the green material and the cured hay. The chief difficulty in using these crops for silage is the cutting and handling of the heavy material without machinery adapted especially for the purpose.

Proper Stage of Maturity for Corn. It is important to fill the silo when the corn is at the proper stage of maturity. Cutting too early results in too much acidity and the maximum feeding value of the corn is not realized. If the corn is allowed to become over-mature, a very large amount of water must be added and the quality of the silage is not the best. Table 65, taken from results obtained at the Purdue Experiment Station, shows the dry matter yield at different stages:

TABLE 65. DRY MATTER IN CORN AT DIFFERENT STAGES

DATE	STAGE OF GROWTH	DRY MATTER PER ACRE
		LBS.
July 24		736
August 6	Tasseling	2,248
August 28	Silks drying	4,746
September 24	Glazing	8,105
October 1	Silage stage	8,929

When corn is in the milk, it contains about one-half the full feeding value of the mature plant. The proper time to cut corn is when it shows the first signs of ripening. In a year of normal rainfall this is when the husks first begin to turn yellow at the end of the ear, while the leaves are still green. The kernels should be dented and glazed.

Sunflowers. This crop is coming into use in regions where, on account of altitude or latitude, the conditions are unfavorable for corn. The yield is usually equal to or greater than that obtained from corn under good conditions. The sunflowers should be cut when the flowers are 25 per cent in bloom.

Other Crops for Silage. Other crops are used in certain localities. Sudan grass, grown to a considerable extent in the South, makes good silage. In Oregon and Washington oats and vetch, and at times wheat, is used with satisfactory result. Beet tops and the refuse material from corn canneries are also preserved to advantage. Rye can be preserved in the silo, but the silage is unpalatable regardless of the stage at which it is cut.

Filling the Silo. The knives on the cutter should be kept in condition so that the forage will be cut properly. The doors of the silo should receive attention in order that the air may be properly excluded. A covering of tarred paper is generally advisable. The silage, especially that next to the wall, must be thoroughly tramped. As a rule two men at least should work in the silo. When the filling is completed, the top should be leveled off and tramped down as thoroughly as possible over the entire surface. The surface should be wet thoroughly by running in considerable water with the last few tons or by putting it on the silage after the filling is complete. The silage should be tramped firmly against the wall daily for several days. Some persons follow the practice of cutting two or three loads of green grass or weeds after the corn is in. The heavy material helps to form a seal. The surface may also be covered with building paper and weighted down. If carefully done, practically no spoiling on the surface will be found.

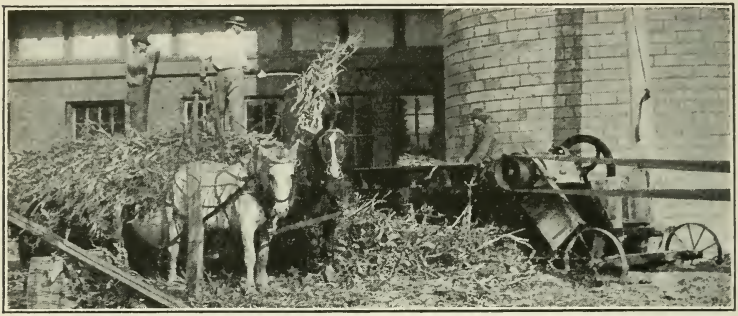


FIG. 81. A silage cutter in operation at the silo. The corn cut usually by a corn binder is hauled to the silage cutter which cuts the forage in half inch lengths and elevates it to the top of the silo either by a powerful blower or by a chain carrier. Silage cutters range in capacity from five to fifteen tons an hour.

A distributor saves much labor and results in a better distribution of the grain with the forage. The cut material should be wet to the touch. If the corn was at the proper stage of maturity, no water will be needed. If past the proper stage, or if the corn becomes dry in the field after cutting, water should be added. If the corn has reached the stage where the leaves are dry, a large amount of water will be necessary.

Spoiling of Silage. Two types of spoiling are found in silage. The most common is molding. The other is rotting. Both forms of spoiling require the presence of air before they can develop. The main factor therefore in preserving silage is a complete exclusion of air. Air cannot be excluded unless the silage is wet. Moldy silage, unless around the wall or doors, nearly always indicates lack of sufficient moisture at time of filling. It may also be found near the wall and doors as a result of the walls not being tight, and so allowing air to enter through cracks or around the doors. A lack of sufficient tramping next to the wall during filling may also be the cause of the trouble. The rotting of silage appears when air gains access to silage having plenty of moisture. It usually is found near the doors and may be accompanied by the development of considerable heat.

Capacity of Silos. The weight of silage is subject to considerable variation, due especially to the wide differences in water content and, to some extent, to the amount of grain contained in it. King in 1893 published a table giving the estimated weight of silage for silos of different sizes. His figures gave results somewhat too high on account of the practice in recent years of allowing the corn to reach a more mature stage before putting it in the silo. The author and his associates have published a new table for this purpose based upon results from thirty-three silos. This table is found in the Appendix.

CHAPTER XXXI

THE SOILING SYSTEM AND SOILING CROPS

Soiling means growing green forage, cutting and bringing it to the stock, in place of allowing them to eat the green feed where it grows. This system is one that, as a rule goes with intensive farming and high-priced lands. It is also practiced in some other regions because the conditions there are such that good pasture cannot be had. In many parts of the world—for example, the greater part of Germany—cattle are never grazed. The system is also followed to some extent in the Eastern States.

General Advantages of Soiling. When green feeds are used only to supplement pastures for part of the season, it is spoken of as partial soiling. When the animals are sustained entirely on green feed, cut and hauled to them, the plan is called complete soiling. It is not implied in either case that the animals do not receive any feed, such as grain, other than the green feed given, but that green feed constitutes the main part of the ration. On account of the comparative cheapness of land over the greater part of the United States, the system is not as yet practiced except in isolated localities. Its advantages are:

1. Saving of land.
2. Saving of fencing.
3. Saving of the manure.
4. Animals kept in better condition.

Saving of Land. The greatest advantage that can be urged for soiling is the much greater return in the way of feed that it is possible to secure from a given area. This saving of land comes about in three particular ways. The most important is that the crops are allowed to become more mature before being used. When pasture grass is eaten in an immature form, it is not given opportunity to utilize its leaves and roots to the best advantage to build up the plant. It is a demonstrated fact, for example, that the corn plant gathers the greater part of its nutrients after the plant is fully grown. If the growth should be cut off as soon as it reached the height of a few inches, the yield of feed per acre would be very small. The same is true, to a slighter degree, however, with grasses. Forage crops used for soiling are cut when nearly mature, but before they have become woody and unpalatable.

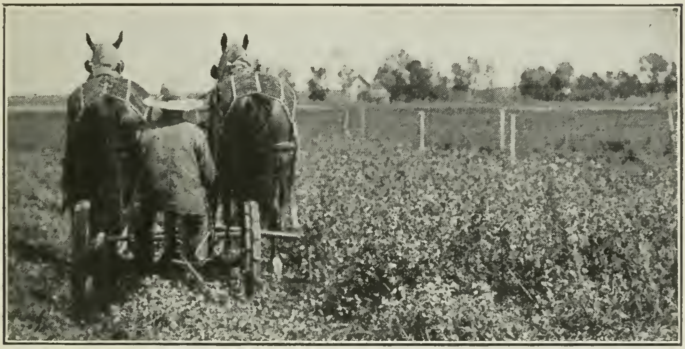


Fig. 82. Mowing field peas and oats for soiling. This is one of the best soiling crops where climatic conditions are favorable. One of the chief objections to the soiling system is that the feed has to be cut and hauled daily.

The second reason why pasturing does not yield as much feed as soiling crops is that in the former the plants are injured by the treading of the feet and the soiling of the grass with manure.

A third reason to be taken into account is the injury done to the land by the trampling of the stock, especially during wet weather.

By following the soiling system, Detrick,[1] whose remarkable results have been widely quoted, was able to raise all the roughness needed for 30 head of stock, of which 17 were cows in milk, on 17 acres. The land on which these results were obtained was, in the beginning, so run down that it would hardly support 3 animals. The fertility was built up by barnyard manure until two crops per year, together equal to about 6.7 tons of hay per acre, were produced.

---

[1] Farmers' Bulletin No. 242, U. S. Department of Agriculture.

At the Wisconsin Experiment Station 3 cows were maintained on 1.5 acres of soiling crops. Three other cows on pasture required 3.7 acres. The conclusion was drawn from this work that one acre of soiling crops equals 2.5 acres of pasture.

The Connecticut Experiment Station maintained four cows from June 1 to November 1 on 2.5 acres of soiling crops. The Kansas Experiment Station[1] reports the following results in a year of more than average good pastures. Ten cows were used.

Crop	Days Fed	Yield per Acre Lbs.	Value per Acre
Alfalfa	14	77,145	$25.26
Oats	9	12,325	6.81
Corn	31	38,695	22.79
Sorghum	15	22,370	15.60
Kaffir Corn . . .	14	17,550	13.83

The average consumption was 116 pounds per head daily and .71 acre fed one cow for 144 days. The financial returns are based upon the creamery price for butter fat. On the same basis the pasture yielded $4.23 per acre.

Taking into account all the data reported, it seems conservative to say that when following the soiling system one acre will produce at least twice as much, and often three times as much food as an acre of pasture.

Saving of Fencing. The second advantage of the soiling system is the saving of fencing. Fences are an item of large expense on any stock farm, especially when it is necessary to divide the land into small areas in order to utilize it to the best advantage. The initial cost of fences is considerable, and in addition they require almost continual repairs. In addition, the land near the fence cannot be utilized, and it is only by additional labor that unsightly weeds may be prevented from growing in this strip. This expense for fences is largely eliminated by the soiling system. In Germany, where the soiling system is almost universal, no fences at all are in use. Practically no fences are used in Denmark, where the cows are not turned loose on pasture, but are tethered out constantly.

---

[1] Kansas Experiment Station, Bulletin No. 119.

Saving of Manure. The third advantage is the better saving of the manure. The value of barnyard manure to the fertility of the farm is recognized in every successful farming region where anything like a permanent system of agriculture has been established. The actual value of the excreta passed by a cow in a year for fertilizing purposes is about $30, if all is preserved. If the animals are on pasture, nearly half of this will be dropped in the pasture. In most cases a much greater value would be realized from applying this fertilizer to other parts of the farm more in need of improvement. When the cattle are kept housed as they usually are when soiling is practiced, the manure may be preserved and applied when most needed. On some farms this is a point of great importance.

Animals Kept in Better Condition. Animals are kept in better condition, as a rule, where the soiling system is followed than when they are pastured. This results from a more regular feed supply, ample at all times to allow of profitable production. The serious decline in milk production, for example, experienced in midsummer by most cow owners following the pasturing plan, is almost entirely avoided. At the same time, the labor and expense of getting these additional results must be taken into consideration.

Objections to the Soiling System. There are two objections to the soiling system which prevent its wider adoption:

(1) the labor problem, and (2) difficulty of providing a suitable series of crops and adjusting the amounts of each.

The soiling system involves a much greater expense for labor than when the pasturing system is used. The green feed must be cut each day, or at the outside, every second day. The common practice is to cut it daily, except Sunday, when the animals are fed from a larger amount prepared the previous day. Since the amount required per day is approximately 100 pounds per cow, the weight to be handled is considerable, making the labor heavy.

A further difficulty about the labor feature is the regularity required of attendants, which is difficult to secure. In addition to preparing the green food, the labor of handling the manure and caring for the animals from day to day must be considered. Furthermore the difficulty of securing a suitable succession of crops in about the right quantity requires careful planning when complete soiling is practiced. There must be a succession ready to use all the time, and in about the proper quantities. A surplus may usually be made into hay, but this is not always convenient.

Crops for Soiling. The crops to be grown for soiling purposes depend naturally upon the local conditions, and no general statement can be made to cover all conditions. Information regarding the best crops for the purpose can be had from the nearest experiment station. Shaw[1] gives the following list of suitable crops:

> For Canada and the Eastern States north of the Ohio River: winter rye, alfalfa, medium clover, mammoth clover, peas and oats, corn, sorghum, millet, and field roots.
>
> For the northern part of the Mississippi valley: the same except for alfalfa which is omitted.
>
> For the Southern States: winter rye, winter oats, crimson clover, corn, sorghum, cow-peas, and rape are suggested. In sections where alfalfa can be grown, it should be included by all means. In the southwestern part

---

[1] *Soiling Crops and the Silo.*

of the United States more attention should be given to alfalfa, soy-beans, and Kaffir corn.

The recommendation of the Pennsylvania Experiment Station[1] regarding succession of crops and acreage for ten cows is given in Table 66.

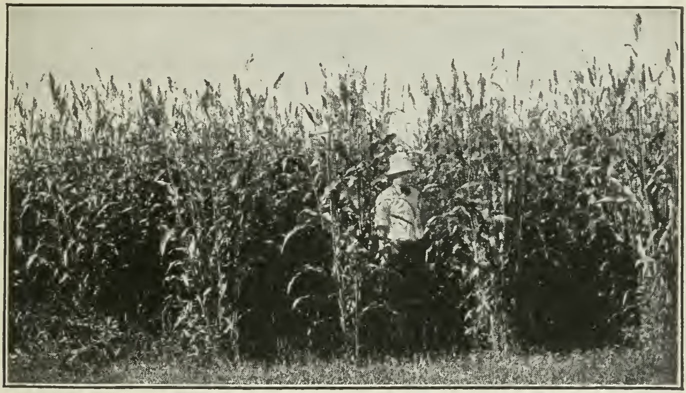


FIG. 83. Sorghum grown as a soiling crop. Where climatic conditions are favorable this crop is excellent for soiling purposes. It yields heavily, is palatable and is ready for use later in the summer.

TABLE 66. SOILING SYSTEM SUGGESTED BY PENNSYLVANIA EXPERIMENT STATION

CROP	AREA	WHEN TO BE FED
Rye	½ acre	May 15–June 12
Alfalfa	2 acres	June 1–June 12
Clover and timothy	¾ acre	June 12–June 24
Peas and oats	1 acre	June 24–July 15
Alfalfa (2d crop)	2 acres	July 15–Aug. 1
Sorghum and cow-peas (after rye)	½ acre	Aug. 11–Aug. 28
Cow-peas (after peas and oats)	1 acre	Aug. 28–Sept. 30

---

[1] Bulletin No. 75 (1904).

Suggestions by McCandlish based upon work at the Iowa Experiment Station for a soiling system using alfalfa are given in Table 67.

TABLE 67. A SOILING SYSTEM WITH ALFALFA

CROP	AREA, ACRES	APPROXIMATE DATE OF SOWING	APPROXIMATE DATE OF HARVESTING	APPROXIMATE YIELD PER ACRE TONS
Alfalfa, first cutting	½	Previous year	June 10–20	8
Oats and Canadian field peas	1	April 5	June 15–July 5	6
Oats and Canadian field peas	½	April 20	June 30–July 30	5
Alfalfa, second cutting	½	Previous year	July 5–15	4
Oats and Canadian field peas	½	May 5	July 10–25	5
Amber Cane . . .	1	May 20	July 20–Aug. 20	12
Amber Cane . . .	1	June 20	Aug. 15–Sept. 20	12
Amber Cane . . .	1	July 5	Sept. 10–Oct. 15	12

CHAPTER XXXII

STABLES FOR COWS

The dairy cow, unlike the fattening steer that is protected by layers of fat, needs to be comfortably housed if she is to do good work. Exposure to cold—and especially to cold rains—results in much larger losses than the actual amount of feed required to maintain the animal heat under the unfavorable conditions. The importance of housing is generally understood and practiced in the colder climates. As a rule, more losses from exposure occur in those regions where, from the usual mildness of the climate, sufficient provision is not made for the severe weather that occurs only at intervals.

Where the importance of proper stabling is recognized, the conditions existing are, on the average, far from what they should be. It must be recognized that the stable is a place in which human food is produced, and, further, that the health and even the lives of the children of the country depend to a large extent upon the conditions existing in the stables where the milk, which serves as their main food, is produced. There is a strong and growing demand on the part of milk consumers and officials who have to do with the health conditions of the cities for better sanitation in the barns and dairies. Laws and regulations regarding this matter are becoming more stringent, and an immense improvement has been brought about within the past few years, but there is still a great deal to be accomplished along the line of more sanitary and comfortable housing of dairy cattle.

Better Barns Mean Cheaper Production. There is another phase of the subject that must be emphasized as well. There is no doubt that it pays as a financial proposition to have well-arranged, sanitary barns which make the cow more productive by making her more comfortable; which make labor more efficient on account of being better satisfied; and which lessen the expense of labor by their convenience in arrangement. A sanitary barn is not necessarily an expensive one. Many an inexpensive structure is or may be more sanitary than some ill-arranged, badly kept, but expensive barn.

In considering the matter of barns, it is well to study carefully how closely the conditions of early summer may be maintained throughout the year. The dairy cow does her best in the early part of the summer when on a good pasture. The maximum production reached at this season is possibly largely on account of the excellence of the food, but at the same time the animal enjoys a moderate temperature and clean, comfortable surroundings. There is an abundance of fresh air and sunlight, and the cow has perfect freedom of movement. Keep as near these conditions as possible in the barn, and good results will follow. A cow housed in a dark basement barn, surrounded by foul air, with her head fast in a rigid stanchion and her body more or less filthy is as far from summer conditions as her milk production is below that of early summer.

Types of Barns. There are a variety of barns, but they may be divided into a few rather distinct types, while many are intermediate:

1. The basement barn
2. The two-story or loft barn
3. The one-story or shed barn
4. The round barn
5. The covered barnyard or double stabling system

The basement barn. The basement barn is a favorite type in the northern part of the United States, especially in the Eastern States. It cannot, by any means, be recommended as an ideal dairy barn. It is built by excavating into the side of a hill, sufficiently to bring the top of the first story on one side and usually on two sides, at the level of the ground outside, the south and east sides commonly being full height above ground. This type of barn is warm, but usually very unsanitary, on account of having practically no light and no ventilation. It can be ventilated, but rarely is this done. Space for storage is usually provided above the animals, with a driveway running directly into the loft.

The two-story or loft barn. This style of barn allows for the stabling of the stock on the first floor, with a second story for storage above. The walls of the first story may be of stone or wood, but are all above ground. This style is well adapted to the general farm, where considerable room is required to store the loose hay and other feeds grown on the farm for winter use. Storage room is secured more cheaply in this manner than by building a one-story cow barn and a separate storage barn. This style may be entirely sanitary in its construction if properly arranged. It should have plenty of light and a good ventilating system. The ceiling above the cows should be tight, to prevent dust from falling and so contaminating the milk, and to avoid

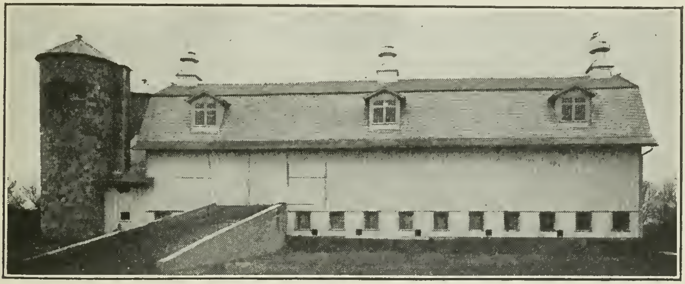


Fig. 84. A two-story or loft barn

The stable for cows is on the ground floor with a loft above for hay storage. This style is well adapted for general farm use where a large loft is needed for storing loose hay. Note the numerous windows, also the ventilator outlets on the roof and the intakes near the bottom of the windows.

the odor from the stable and the breath of the animals from injuring the palatability of the feed above.

The one-story or shed barn. This is one of the best types of barn from the standpoint of sanitation and convenience. It usually is built wide enough for two rows of cows. This plan is especially adapted for use where it is not necessary to have any large amount of storage room for unbaled hay or bedding. It is often used, however, where ample storage room must be provided; and in such cases a portion of the barn is usually built two stories high, and serves for storage and general purposes, while one or more single-storied wings are provided to house the cattle. Single-storied barns usually have a tight ceiling, although some are open to the roof and have a monitor top to admit light from above. The objection to having the space open to the roof is that in cold climates this space is so great that the barn is too cold in winter.

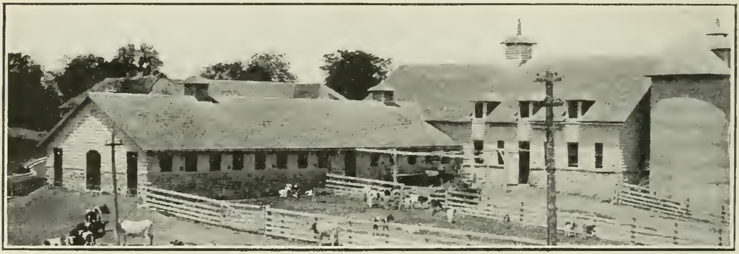


FIG. 85. A one-story cow barn with a two-story portion attached for storage of hay and grain

The one-story wing has stalls for 58 cows. The calf pens and maternity pens are on the first floor of the two-story part. Note the large number of windows and the good drainage to the yards.

The advantages of the one-story barn are that it may be well lighted and ventilated and its construction made sanitary in every way. Additional room can be easily had by extending the wings at any time.

The round barn. The economy of construction in the round barn was first called to attention by King[1]. According to this author, a round barn requires 25 per cent less wall to inclose it than does an ordinary rectangular type.

According to Frazer[2], a round barn with room for 40 cows requires 22 per cent less walls and from 34 to 58 per cent less material than a rectangular building with accommodations for the same number of animals. The silo is built in the center, and the cows are usually arranged in a single row around the barn, headed toward the center, except where the barn is too large, when a double row is used. The round barn has not won its way in popular favor. Its disadvantages are difficulty in filling the silo, and the impracticability of increasing its size by building additions.

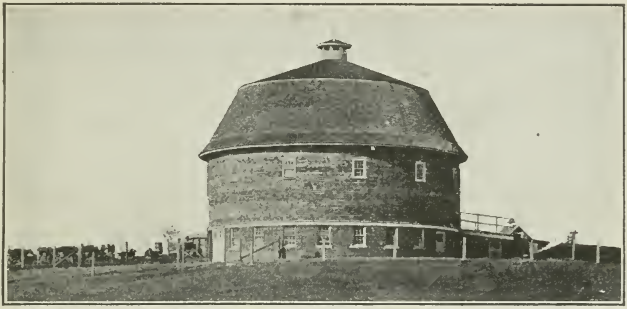


FIG. 86. A round barn

This barn is used at the University of Illinois. A round barn is economical to build but the silo located in the center is inconvenient to fill, the barn is dark in the center and the space difficult to use to the best advantage.

The covered yard or double system of housing. This plan was first called to the attention of the public by Professor Roberts[3] of Cornell University, who used it for many years with the station herd of dairy cows. The plan consists in having a large shed or covered yard, into which the cattle are turned loose except at milking time. The roughness is usually fed in racks to be consumed at will, while the grain is fed when the cows are taken to the milking stable at milking time. The milking stable need not be elaborate, but it must be sanitary. The cows are tied while they eat their grain and are milked. This system gives the cows a maximum amount of freedom, but requires an abundance of straw for bedding, and it is more expensive if a new and sanitary plant is built. At times an old barn may be economically utilized in this manner.

---

[1] *Physics of Agriculture.*
[2] Bulletin No. 143, Illinois Experiment Station.
[3] Bulletin No. 13, Cornell University Experiment Station.

Location of the Barn. The barn should be located where there is good drainage, making it possible to keep the yards in good condition. Convenience in location as well as in plan should receive careful consideration, since the expense for labor depends to no small degree upon proper location and internal arrangements of the barn.

A rectangular barn should stand preferably north and south, or with long axis northwest and southwest, making it possible to get sunlight on both sides at some time during the day.

Lighting. One of the most serious defects in most barns, particularly the older ones, is lack of sufficient light. Windows cost but little if any more than other wall space, and cannot be objected to on this account. Plenty of light is one of the most essential things about a good barn. It is necessary to keep the animals in a healthful condition, and is of the greatest importance in a sanitary way. Not only does sunlight destroy germs, but where there is plenty of light, uncleanly conditions are easily seen and corrected. A dark barn is almost always a dirty barn. There should be at least 4 square feet of glass to each animal. The bottom of the windows should be 4 or 4½ feet from the floor; if lower, the animals are liable to break the glass. The windows should extend nearly to the ceiling in order to allow the sunlight to reach as much of the floor as possible, and should set flush with the inside wall to avoid making a ledge for the accumulation of dust. In a one-story barn the windows should be hinged at the bottom. In a two-story barn, which gives ample room above, the sash had better slide upward. This arrangement is much more convenient than having one sash slide past the other in the ordinary manner. In sections where the winters are severe, the barn may be made more comfortable by the use of storm windows and double doors.

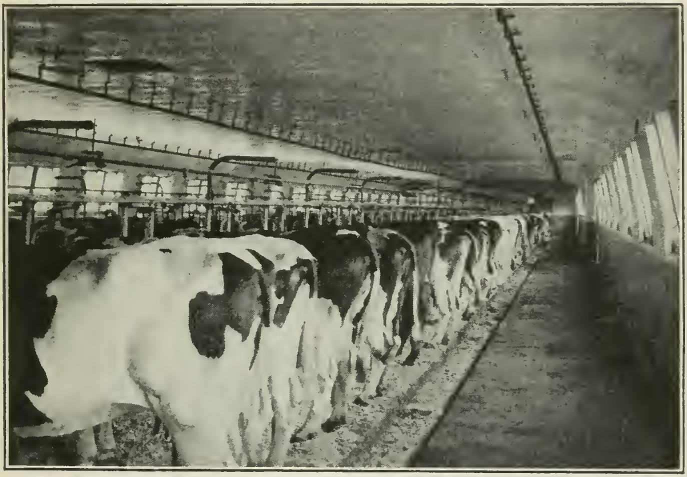


FIG. 87. A well lighted barn

An abundance of light is the first requirement for a sanitary barn. A light barn is usually kept clean, a dark barn seldom. Note the windows extend to the ceiling leaving a high wainscoting below.

Floor Construction. One of the most important points to be considered in planning a barn is the material to be used for floors. Material for a floor should have the following characteristics:

1. Impervious to moisture
2. Sanitary and easily cleaned
3. Comfortable for the cows
4. First cost not too great
5. Durable

The floors in common use are as follows:

1. Dirt with wood or cement gutters
2. Wood
3. Brick
4. Cork brick
5. Cement or granitoid

Dirt floors. A floor of dirt in a dairy barn is excusable only under primitive conditions. This material provides comfort for the animal and is cheap in construction. The objections are of course, that it cannot be kept clean and that it cannot be disinfected after an outbreak of disease. The most objectionable condition is that of the cow's standing on a level dirt floor without any gutter. A fairly good floor for ordinary purposes may be made by building a gutter of cement or wood, and extending this forward far enough to catch the urine. The space under the cows is then filled with clay packed solidly. When sufficient bedding is used, such a floor will answer in a cheap barn, but under no circumstances could such a barn be called sanitary.

Wood for floors. A tight, wooden floor is comfortable for the animals and may be kept in good condition regarding cleanliness, although it can hardly be considered first class from a sanitary standpoint. The first cost is also excessive, considered in connection with the short time it remains in service. Wooden floors last longest when laid either in contact with earth so that moisture is retained constantly or with sufficient air space below to admit of free circulation of air. Under the most favorable conditions, a wooden floor may last as long as from six to ten years. The most rapid decay occurs when the floor is laid far enough above the soil that only a small amount of moisture is present and when there is no circulation of air underneath. Under such conditions the floor may not last longer than from three to five years.

Wooden floors are made water-tight by using coal tar between the planks. The most serious objection to the wooden floor is its short period of service. When moist, a wood floor is slippery and cows are liable to severe falls while they are moving about. Another objection of considerable weight in many cases is the sanitary question. On account of the difficulty of cleaning, a wooden floor is not used where the greatest attention is paid to sanitation.

Brick for floors. If good vitrified brick can be bought cheaper than cement, this material may be used with advantage. A brick floor has the same advantages and objections as those discussed in connection with cement. The bricks must be put on a good foundation, and are set in cement.

Cork brick. For stall floors, cork brick is fairly popular. While the initial cost is rather high, it makes a floor which is comfortable, sanitary, easily cleaned, and fairly durable.

Cement floors. Cement or concrete floors have more of the requirements for a good floor than any other material in general use. This material is impervious to moisture, very durable, and the most sanitary and easily cleaned of all. The first cost is but little more than wood in most localities, and its lasting properties make it much cheaper, considering a term of years. The one serious objection to cement is in regard to the comfort of the animal. A cement floor is cold, that is to say, it is a good conductor of heat, and for this reason seems cold. It is believed by many of the most experienced dairymen that udder troubles are brought on from cows lying on cement floors. This difficulty may be lessened by having the floor from 6 to 9[1] inches higher than the surface of the ground on the outside to prevent water from flowing under the cement. The floor should be thoroughly insulated with a layer of cinders 6 to 9 inches deep under the cement. Such arrangement, together with a liberal use of bedding, will obviate most of the danger from the coldness of the cement. Another arrangement which has much to recommend

[1] Erf., 15th Annual Report Ohio State Dairy Association, 1909.

it is the placing of a wooden platform over the cement where the cows stand. This platform may be made of planks imbedded in coal tar or in the form of a loose frame that may be removed for cleaning.

Another serious objection to cement is the slipping of the animals as they come through the passageways. A cement floor should never be troweled to a smooth finish, but left with the surface rough, as finished with a board. In some barns sand is sprinkled on the floor daily to prevent the animals from slipping. Another trouble that often occurs is injury to the knees of the cows. In reaching into the manger for food the forefeet slip and the cows drop on their knees which results after a time in enlarged joints. This trouble is in a large measure avoided by making a depression of an inch where the forefeet stand.

Probably the best plan is to construct the entire floor of the barn—including stalls, passageways and mangers—of cement, then to cover the platform where the cows stand, as suggested, with wood, or to pave the stalls with cork brick on a cement foundation. Creosote wood blocks also make a satisfactory stall floor when carefully laid on a good foundation and the joints flushed with cement wash.

Walls Construction. Wood, concrete, tile, masonry, or brick may all be used in the construction of barn walls, and the cost will ordinarily be the determining factor. The inside of

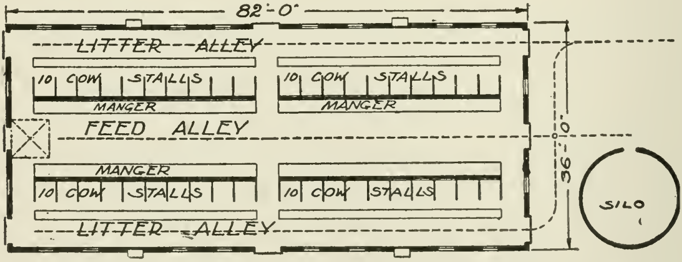


Fig. 88. Floor plan of a barn to house 40 cows. No provision is made in this barn for calves, bulls or young stock

the walls should be smooth in order to be easily kept clean. A well painted, tight, wooden wall is as easy to keep clean as one of concrete. The matter of warmth enters into the selection of material for the walls, and the walls should be insulated to prevent condensation of moisture in the form of frost during cold weather. A wall made of lumber with tar paper underneath, and an air space between the outer and inner surfaces proves fairly warm. Hollow tile with its dead air space makes an excellent barn wall. Concrete is extensively used, but when built up solid it is cold and the moisture in the air of the barn condenses on the surface of the concrete, sometimes forming a very thick coating of frost. This may be remedied to a large extent by a double wall with an air space between; but this entails additional cost of construction. In localities where winters are mild, concrete is unquestionably the best material for at least the lower section of the barn walls because of its durability and the ease with which it can be kept clean.

Arrangement of Cattle in Barn. The best and most commonly used plan is to stand the cattle in a double row, thus making it possible to light the entire stable readily and to feed and remove the manure conveniently. There is much discussion as to the comparative advantages of placing the cows with their heads together or with heads outward. There are some advantages in favor of each. When facing the center, both rows may be fed by making one trip down the passageway with the feed truck, distributing the feed on both sides. The removal of the manure is most convenient when the animals are headed out, since by driving through with the manure spreader and loading directly from the trenches, considerable labor is saved, or if a track carrier is used, it may be loaded readily from both gutters. The cows present a better appearance to visitors when headed out; the walls of the barn do not become splashed with manure, and there is some advantage in regard to ventilation, since the fresh air usually enters along the outside wall. Facing inward brings the milker nearer to the light and enables him to see if the udder is clean. However, the opposite arrangement is more convenient when milking machines are used. The greatest difficulty that is usually experienced in heading the animals outward is the construction of the barn without the use of center posts that obstruct the passageway behind the animals. When the cows are headed toward the center, the posts for support are made part of the stanchion manger supports, and are not in the way. However, with more expense it is possible to support the longer span required with trusses when the cows are headed outward. Figures 90 and 91 show cross-sections of barns conveniently arranged. The width of the barn is 36 feet. The walls should have cement plaster 3 feet high made with a rounded corner to prevent accumulation of dirt. The passageways should be of ample width to facilitate feeding and cleaning out.

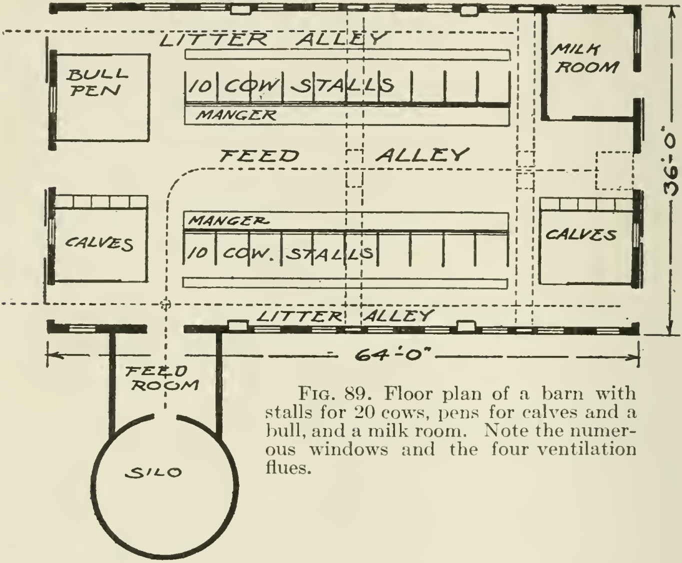


FIG. 89. Floor plan of a barn with stalls for 20 cows, pens for calves and a bull, and a milk room. Note the numerous windows and the four ventilation flues.

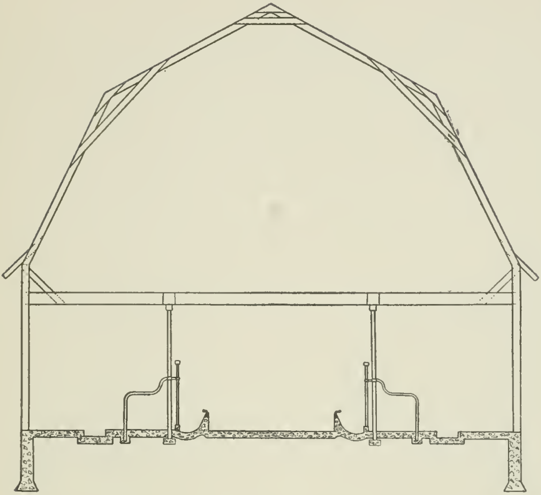


Fig. 90. A cross-section of a two-story barn

The cows are facing the center in this diagram but can be reversed. The modern loft barn is braced without heavy timbers resulting in a saving of timber as compared to the older style and in a much more convenient mow in which to store hay.

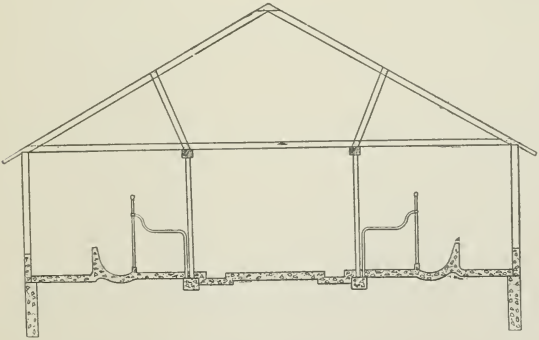


Fig. 91. A cross-section of a one-story cow barn

In this diagram the cows are faced outward. They may be faced toward the center if preferred. This type of barn is suitable where storage for hay is not needed.

Gutters. The gutter is highly important in connection with keeping the cow clean. It should be of ample depth, as otherwise cows are apt to stand with the hind feet in the gutter. The depth should not be less than 8 inches, while 10 or 12 inches is better. The proper width is not less than 16 inches. The danger from deep gutters is that the cows will slip and injure themselves. This may be largely eliminated by lowering the passageway behind, making this side of the gutter only 6 inches deep.

Mangers. There are numerous types of mangers. From a sanitary standpoint cement is the best material for construction. All corners should be rounded to facilitate cleaning. The most common type is the continuous manger, which is built in the form of a long trough before the cows. Some objections are raised to this construction, on account of the chance it affords one cow to rob another of her feed. In case of contagious diseases like tuberculosis, there is also much more danger of communication from one animal to another in such a manger. Partitions of sheet iron are sometimes used. The special advantage of the continuous manger is the ease of cleaning by sweeping out refuse feed. It may also be used as a means of watering the cows in the barn with advantage; but here again lies the danger of spreading contagious diseases. Figure 92 shows a cross-section of a barn from the middle of the feedway to the outer wall, giving the proper dimensions. The width of the manger should be not less than 2 feet, and preferably it should be 2 feet 6 inches. The bottom of the manger should be 1 or 2 inches higher than the platform where the cows stand. The partition next to the platform on which the cows stand should be 6 or 8 inches above the level of the bottom of the manger.

The comfort of the cows and the success in keeping them clean depends largely upon the construction of the platform. It is highly important that it be of proper length and of suitable material.

The construction to be recommended most highly is of cement covered with a wooden platform, or, better still, concrete overlaid with cork brick or creosote wood blocks. A cement platform should have a depression one inch deep and 14 inches wide next to the tie. The surface of this depression should be slightly fluted. The object in this is to prevent the cows from slipping and falling on their knees when reaching for feed. It also allows the cow to stand on the level, since the platform slopes one inch from the rear of this depression to the front edge of the gutter. The success of keeping the cow clean depends largely upon having a platform of proper length. The length to be used varies from 4 feet 6 inches to 5 feet, depending upon the size of the cows. The former is the proper length for Jerseys, and the latter for cows of the size of Holsteins. Some provision should be made to accommodate cows of different size, since they vary in any herd with age. One plan often followed is to make the platform 4 inches longer at one end than at the other, with a gradual slant between. The cows are then arranged according to size. Another arrangement having much to recommend it is an adjustable stanchion so made that it may be set back 3 or 4 inches from the support, or set ahead the same distance for long cows.

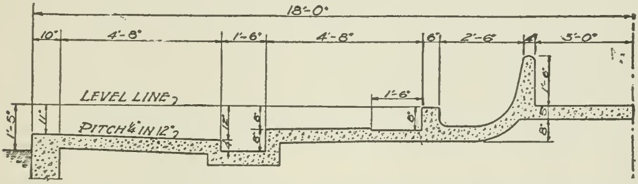


Fig. 92. Cross-section of a barn from the middle to the outer wall. The success of a barn depends upon getting the dimensions exactly right, especially of the manger and platform.

Ties and Stanchions. There are a great variety of ties in use. The most objectionable way to tie a cow is to fasten her to a manger where she must back up to lie down. This is bound to result in filthy animals, since they are compelled to lie in their droppings. The cow should be so fastened that she lies down exactly where she stands, or a little forward if possible, and the platform should be the proper length so the manure drops in the gutter.

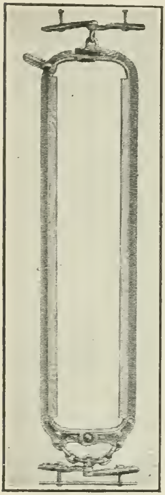


FIG. 93. A modern stanchion.

The tie most widely used is a stanchion hung on a chain or swivel at top and bottom and made of steel. A wooden lining is often provided.

The most common ties in use are various forms of stanchions. There is no kind of tie that keeps the cows cleaner than the rigid stanchion, provided the platform and gutter are properly made. The rigid stanchion, however, is not well suited for a tie, as the cow has no freedom of movement and cannot lie in a natural position. Many other forms of stanchions are in use that are quite satisfactory. One is hung on pegs at top and bottom, allowing a movement sideways. Another is hung on chains at top and bottom, which gives more freedom. For general use these improved forms of the stanchion find the most favor. Stanchions may be made of iron pipe or wood, but the former is the more sanitary and more durable, and equally comfortable for the animal.

The double-post slip chain tie is equally comfortable for the animal, but not quite so convenient for use.

Stanchion or chain ties may be attached to either iron or wooden framework as supports. The iron is most sanitary, and has the additional advantage of being more sightly. An iron pipe partition made of gas pipe, with the bottom set in the cement floor, is to be recommended.

Box Stalls. Box stalls to be used for maternity stalls and for stabling sick animals should be provided, but these, along with pens for calves, should preferably be located in a part of the barn separate from the main cow barn. The wing or section used for housing the milking herd should be used for that purpose alone, as this insures the least amount of noise and confusion. High-producing dairy cows can only do their best work in a peaceful environment.

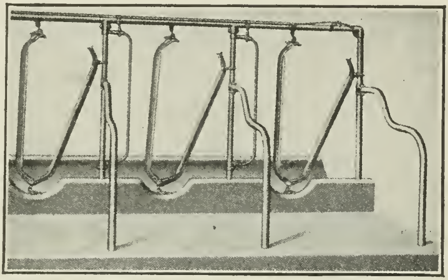


FIG. 94. Modern steel stalls with concrete manger and platform

Water Supply and Drainage. A modern cow barn should have a suitable drainage system, so arranged that the liquid manure may be conducted to a manure cistern, or else carried off to a natural drain some distance from the barn. The gutters should have traps to catch litter and prevent clogging up the drain tiles. Box stalls and calf pens require less bedding and are more sanitary if provided with floor drains.

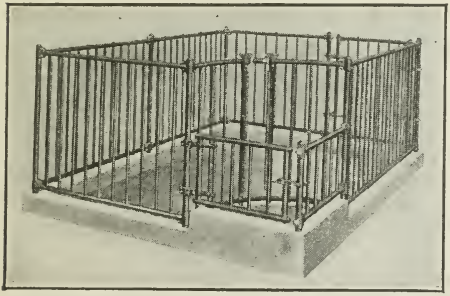


FIG. 95. A modern box stall of steel construction
Box stalls are needed in every dairy barn for use by cows at time of freshening and for sick animals

Running water is a necessity in the cow barn, both for watering the cows and for cleaning purposes. The individual drinking cup is now regarded as the most satisfactory method of keeping a continuous supply of water before the cows, and results in their drinking more water, especially in cold weather when the water in outdoor tanks approaches freezing temperature.

Ventilation. An abundance of pure air for animals of all kinds is scarcely less important than are proper methods of feeding. It is only within recent years that the full significance of an abundant supply of oxygen to animal life has been comprehended. While there may be some excuse at times for insufficient or improper feeding of animals, there is none for failure to supply plenty of air.

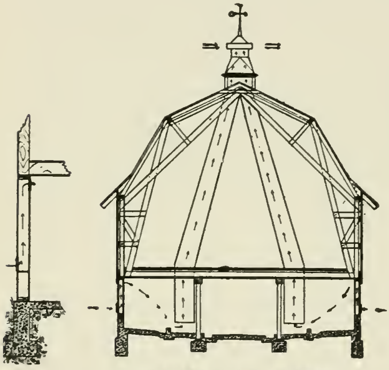


FIG. 96. Ventilating flues according to the King system

The intake is shown on the left. The flue must be large and the foul air is taken from near the floor. A suitable outlet is necessary on the roof to utilize the full force of the wind.

Good ventilation for dairy barns is not only necessary from the standpoint of the health of the animals, but it is necessary for the most economical production of milk. The air breathed by an animal is as indispensable as the hay and grain eaten, for neither assimilation of food nor generation of energy can take place without the consumption of a proportionate amount of pure air. Dairymen are largely indebted to Professor King for information on this subject, as well as for the best practical system of applying this knowledge.

The cow gives off carbon dioxide, moisture, ammonia, marsh gas, and some other organic matter from the lungs. A candle will be extinguished if placed in a jar containing the air exhaled from the cow's lungs. A cow weighing 1,000 pounds inhales 224 pounds of air in 24 hours, or about double the amount by weight of her food and drink. This is at the rate of 3,542 cubic feet per hour. To supply this amount of air for 20 cows will require a ventilating flue 2 by 2 feet, in which the air moves at a velocity of 295 feet per minute. In providing pure air for stables the cubic space per animal has little significance. The important question is the amount of fresh air provided.

Forces producing ventilation. There are three main forces that cause movement of air in a stable.

1. The wind pressure against the side of the building, which tends to force air into the building and out on the opposite side or upward through the ventilators.

2. The wind in blowing across the top of a ventilating flue produces an outward suction.

3. The difference in temperature between the air in the barn and that on the outside is due to the heat radiated by the animals, and also the increased moisture content of the expired air. This causes an upward movement in a ventilating shaft by a force equal to the difference in weight of the air outside and within.

The King system. This is the system in general use in modern dairy barns. The main features consist of a large flue opening near the floor and extending above the roof of the stable for the escape of the air. A series of smaller openings are arranged on either side for the air to enter.

The object in taking the air from near the floor rather than at the ceiling is to remove the coldest air and the most impure. The warmest and the purest air is found at the ceiling. The ventilating flue should be smooth inside, practically air-tight and, for good results, with no turns. The flue must have ample cross-section. If too small, the friction is sufficient to prevent free movement of the air. In many cases poor results in using this system are to be credited to a ventilating flue of too small size. None should be built less than 2 by 2 feet.

The ventilator flue should have an opening near the ceiling that may be opened when it is desired to increase the draft, and in warmer weather when there is no reason for conserving the heat of the stable. This opening should be regulated with a register.

Entrance for fresh air. Provision must be made for the entrance of outside air. This is taken in at the ceiling and mixes with the warm air. The intakes should extend downward in the wall, with the opening to the outside three feet or more lower than the opening in the barn. This is to prevent the warm air in the stable from flowing out. These intakes should be on all sides of the barn, to take advantage of all wind pressure. They should not be over 4 or 5 by 16 inches in size, and provided with registers to regulate the air passage.

The King system works only while the stable is closed. At such time as it is not desirable to close the barn, the air should be allowed to enter the ventilating flue through the opening near the ceiling. The King system cannot be expected to work in a barn which is not so tightly constructed that the air cannot find entrance or exit at other places. Where properly installed, this system gives excellent results. A barn filled with animals will have no barn odor in the morning after being closed over night where this system is used.

Fan or forced ventilation. Recently the plan of using electrically driven fans for ventilating purposes has come into use to some extent. This is made possible by the equipment of many farms with electrical power. In using the fan system elaborate ventilating flues are not necessary. The fans are located near the ceiling of the barn with a flue extending to the floor in order to draw out the coldest air. The outlet is a flue extending directly through the wall of the barn to the outer air. No inlets are generally provided as the forced draught results in an abundant entrance of air around doors and windows. The advantages of this system are that the installation is less expensive and the successful operation is not affected by atmospheric conditions as the King system. The disadvantages are the expense for current to operate the motors and the vibrations of the motor and fan, which in time become rather disagreeable.

Window ventilation. Some well-constructed barns depend upon hinged windows for ventilation. These are usually hinged at the bottom, so that the top may be tilted inward to the desired extent. Careful, constant attention to this plan may give fair results. The movement of air in this case is dependent upon wind pressure and, furthermore, the warmest and not the coldest air is removed. Windows are not a satisfactory means of ventilation in the winter season, as cross drafts are developed between windows, and much warm air escapes.

Planning to Save Labor. In planning a modern barn, due consideration should be given to the installation of modern labor-saving devices. Manure is now removed from the barn in a litter carrier which operates on an overhead trolley, and the same system is employed in carrying feed from the feed room to the cow barn. A carefully planned arrangement of feed rooms, silos, and milk house will result in more efficient handling of the barn work.

CHAPTER XXXIII

HANDLING MANURE—MATERIAL FOR BEDDING

Composition of Manure. In all countries where agriculture has been highly developed, the value of barnyard manure is fully appreciated. It is saved with great care, and applied to the soil under the best conditions possible. In purchasing feeds, the probable fertilizing value is taken into account, as well as the feeding value.

Large quantities of succulent feeds increase the proportion of liquid manure, and nitrogenous diets produce a manure rich in nitrogen.

Table 68 shows approximately the quantities of urine and dung excreted by cows per thousand pounds of live weight; the distribution of the various fertilizer elements; and value of the manure based on 15 cents per pound for nitrogen, 4 cents per pound for phosphoric acid, 5 cents per pound for potash, and 20 cents per hundred pounds for organic matter; according to data from Cornell Experiment Station:

TABLE 68. AMOUNT AND COMPOSITION OF MANURE EXCRETED BY A 1,000-POUND DAIRY COW

	URINE	DUNG	TOTAL
	LBS.	LBS.	LBS.
Pounds produced per year	8,000	18,000	26,000
Pounds dry matter contained	560	3,600	4,160
Pounds of nitrogen	64	63	127
Pounds phosphoric acid	trace	36	40
Pounds potash	80	45	125
Value Plant Nutrients	$13.60	$13.10	$26.70
Value of Organic Matter	1.10	7.20	8.30
Total commercial value	14.70	20.30	35.00
Value one ton manure	3.65	2.25	2.70

It is a fact often lost sight of in practice that the urine of animals contains by far the most valuable fertilizing constituents of the excreta. That point is brought out by the figures given above, where it is shown that 8,000 pounds of urine excreted contains practically the same amount of nitrogen as the 18,000 pounds of dung, and that of the total of 125 pounds of potash excreted, 80 pounds pass off in the urine. On the basis of the values quoted, the value of the plant nutrients contained in the urine is $13.60 as compared with $13.10 for the dung, and one ton of liquid cow manure has a total value of $3.65, or $1.45 more than a ton of cow dung. These figures emphasize the necessity of preventing the loss of this valuable part of the excrement.

Value of Manure as Measured by Crops. It is recognized that the fairest valuation of barnyard manure is to measure the increase in crops resulting from its application. An abundance of data are available on this subject. Snyder of the Minnesota Experiment Station secured a return of from $2 to $3 a ton when he applied manure to the soil, the larger figure being realized when the soil was one of low fertility. This value represented the actual increase in crops produced in tests covering five years. At this rate the manure from a dairy cow would be worth $25 to $30 a year.

Wiancko[1] reports that "with present prices of crops, manure applied at a normal rate will produce crop increases worth from $2 to over $8 per ton on manure according to the fertility of the soil and the crop grown. The average return in the seven fields reported has been $5 per ton of manure applied." Experiments by the Ohio Experiment Station covering fourteen years showed an average value of $3.31 to the ton of manure.

Amount of Fertility Returned. The proportion of the fertilizing constituents of the ration that is returned in the excrement depends upon the use to which the animal is putting the food.

[1] Bulletin 222, Purdue Experiment Station (1918).

A fattening animal, or a dry cow, returns a high percentage, while the cow milking liberally uses a considerable proportion in the manufacture of the milk. Taking into account the young stock, the dry cows, and the cows in milk in proportions found on the farm, it is, according to Hart[1], safe to assume that at least 80 per cent of the fertilizing constituents present in the feed used are voided in the liquid and solid excreta. The cow in milk, according to Warren[2], voids approximately the following proportion of her food intake as excrement.

	Per Cent
Dry matter	45.5
Organic matter	43.3
Nitrogen	44.3
Mineral matter	63.6

If organic matter is needed in the soil, it may be fed dairy cows and there will still be nearly half for use in the fertilizer. The same is true for nitrogen, potash, and phosphorus.

Losses in Manure. Not all the manure produced by an animal reaches the field, and losses are due principally to leaching, fermentation, failure to save the liquid, and dropping outside the barn. Unless the manure is hauled immediately to the fields there is bound to be some loss of fertilizer constituents, regardless of what method of storage is used; but every effort should be made to handle the manure in such a way as to reduce the losses to a minimum. The New Jersey Experiment Station found that when solid cow manure was exposed to ordinary leaching for 109 days, it lost 37.6 per cent of its nitrogen, 51.9 per cent of its phosphoric acid, and 47.1 per cent of its potash. Mixed dung and urine lost in the same time 51 per cent of its nitrogen, 51.1 per cent of its phosphoric acid, and 61 per cent of its potash. Over one-half of the total value was lost in less than four months' exposure to ordinary weather. The loss in fertility from one cow by the leaching of the manure would amount to $12.50 per year. It would add 25 cents per 100 pounds to the cost of milk from cows producing 5,000 pounds per year. These losses, especially of nitrogen, are partly accounted for by fermentations which set the ammonia free and make the other constituents more soluble. That protection and care of manure pays well is demonstrated by the results of an experiment at the Cornell Experiment Station. Five tons of cow manure was packed lightly in a box and exposed to the elements from April to October. The losses during that period amounted to 49 per cent in total weight, 41 per cent of the nitrogen, 19 per cent of the phosphoric acid, and 8 per cent of the potash. One of the greatest losses in fertilizing value results from the failure to save the liquid excrement of the animal. To prevent this loss the floor, including the gutter behind the animals must be water-tight. Besides, enough litter must be used to absorb the urine so none escapes when the manure is recovered from the barn, or drains must be provided to conduct the liquids to a cistern.

---

[1] Bulletin 221, Wisconsin Experiment Station (1912).
[2] *Dairy Farming*, p. 231 (1916).

Preservation of Manure. The fermentations in manure are checked by using plenty of litter to absorb the liquid manure. A small amount of gypsum may be sprinkled on the moist manure as a means of helping to fix the ammonia. The most important things to be done to preserve the manure are to use sufficient litter for absorbents and where it is necessary to store the manure some time before application to the soil, to keep it compact, moist, and protected from leaching. In the Eastern States it is a common practice to use a manure cellar under the barn. The manure is usually dropped through trap doors from above. Large doors are arranged so that wagons can be backed or driven into the manure cellar for loading. Land plaster is generally used to keep down the odors. The manure is hauled out to the field in the spring or summer. This method preserves the manure fairly well, especially when it is kept compact. The chief objection to this plan is its unsanitary features.

Another provision made for protecting manure is an open shed. In some cases this is in the form of a lean-to along the side of the barn, and the manure is thrown out of the windows under this shed. A much better plan is to build a shed over a shallow pit some distance from the barn, and haul the manure to it with a litter carrier. With this plan the urine is generally drained into the pit which contains the manure, a concrete bottom and sides preventing escape into the ground.

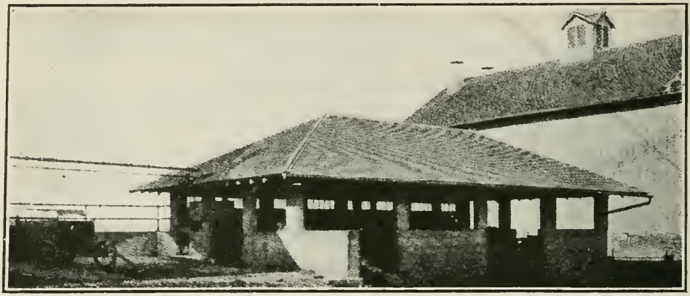


FIG. 97. A manure pit

The manure is dropped in this concrete pit from the overhead carrier. The liquid manure is run into the pit from the floor drain. The accumulated manure is hauled to the field when desired.

It is believed by some authorities that if an impervious floor is provided, sloping toward the center or built in the form of a pit with sides, a roof is not needed and that the rain is beneficial rather than harmful, since leaching cannot occur, and the necessary moisture to help prevent the escape of ammonia is provided. The throwing of manure out under the eaves of the barn results necessarily in the loss of much of its value by excessive leaching, and at the same time it is very objectionable in a sanitary way to have a large accumulation of manure through which cows must wade and in which flies will breed. A barnyard cannot be kept in good condition unless such accumulation of manure is avoided.

Handling Manure. One of the difficult problems in disposing of manure is handling the urine. As already pointed out, it is the most valuable part of the manure, but is often allowed to go to waste. There are two systems in common use for handling urine. One is an underground cistern into which the urine goes through suitable drains from the gutters. This accumulated urine is at intervals pumped into a tank wagon and distributed over the fields from a sprinkler, or a portion is pumped over the solid manure on the spreader before it is taken to the field. If the liquid is allowed to remain in the cistern too long, large losses of nitrogen result from fermentation. The preservation of the liquid manure by means of a cistern and spreading it on the field involves some serious difficulties, and is not to be recommended if it is practicable to supply sufficient amount of bedding to absorb the liquid, or to run the liquid manure through a drain into a manure pit.

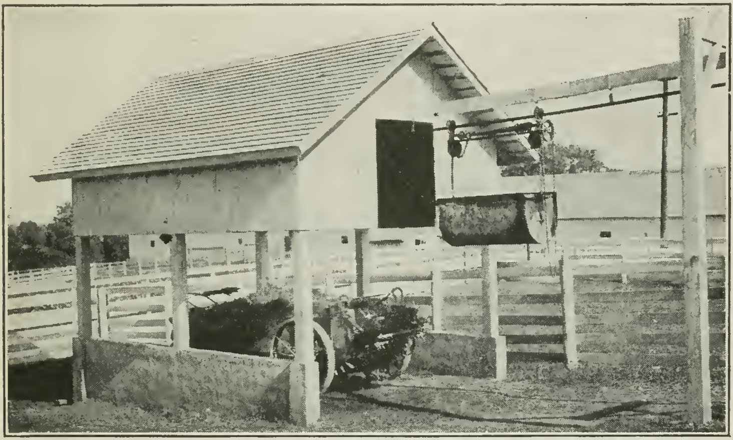


FIG. 98. Loading manure from the carrier into the manure spreader

A plan widely followed is to drop the manure directly into the spreader and haul to the field as soon as a load has accumulated. This plan saves labor, but has some objections.

The method of handling manure which has met with the greatest favor among dairymen in recent years is loading it directly from the barn into a manure spreader. The barn is so arranged that the spreader may be driven through the barn and loaded from the gutters, or an overhead carrier is used, with the track extending into the yard, so arranged that the load may be dumped into the spreader.

When a load has accumulated, it is hauled to the field and scattered. One objection to this plan is that in freezing weather the manure must be unloaded daily to prevent freezing. At times the ground is soft, so it is not desirable to drive over it with a load. It often happens that the ground where it is intended to apply the manure is not ready for the application. There is also some difference of opinion regarding the extent to which losses occur from the washing of recently spread manure when snow melts or rain falls on frozen ground. Analyses made by the Ohio Experiment Station show that manure handled in the usual manner by piling in the barnyard lost over one-third of its value by exposure to three months of winter and spring weather. Manure applied directly to a field from the stall showed a value of $2.96 a ton measured by increase in crops grown, while manure taken from the yard after three months' exposure showed a value of $2.15, a loss in value of 27 per cent.

Taking everything into account, the plan of spreading the manure directly from the stable is to be recommended, but it may be impossible or impracticable to do this at all times.

The Litter Carrier. Perhaps the most valuable part of modern barn equipment is the litter carrier. It makes possible a decided saving in the time required to care for a herd of cattle and lessens the disagreeable features connected with the handling of the manure. The advantages are that the carrier is easily loaded and moved, and that it is possible to haul the manure as far from the barn as desired or to place the spreader on a lower level and dump into it directly.

Bedding. No satisfactory plan has been devised to do away with the necessity of providing bedding of some kind. Bedding is used primarily to keep animals clean and the material that will do this most satisfactorily, and at the same time contribute to the comfort of the animals must be considered the best.

Another purpose, and almost as important as the one of keeping the animals clean, is as an absorbent for urine. Table 69 gives data regarding the absorptive powers of common bedding material as found by trial by Doane at the Maryland Experiment Station.

TABLE 69. ABSORPTIVE POWER OF BEDDING MATERIALS

MATERIAL	WATER ABSORBED PER LB. OF BEDDING	LBS. OF BEDDING REQUIRED TO ABSORB LIQUID MANURE FROM 1 COW 16 HOURS	LBS. OF BEDDING REQUIRED TO ABSORB FOR 24 HOURS
Cut stover	2.5	2.8	4.0
Cut wheat straw	2.0	3.3	5.0
Uncut wheat straw	2.0	3.3	5.0
Sawdust	0.8	8.3	12.5
Shavings	2.2	3.0	4.4

Water retained by 100 pounds of bedding material after 24 hours was found by Whisenand to be as follows:

	LBS.
Oat straw (whole)	250
Cut oat straw (about ½inch lengths)	244
Wheat straw	210
Mixed shavings	119 to 130
Fine, dry white-pine shavings	185
Mixed sawdust	160

In a practical comparative test of oat straw and shavings for bedding dairy cows, he also found that 7.24 pounds of uncut oat straw and 10.15 pounds of shavings were used per day for each animal. His conclusions were that oat straw retained approximately twice as much water as shavings and from 15 to 20 per cent more than wheat straw, and that to keep animals bedded, from 40 to 82 per cent more shavings than oat straw and 9 to 18 per cent more wheat straw than oat straw were required.

Materials for Bedding. Good material for bedding should be itself clean—which means primarily free from dust. The materials to be used on a certain farm will depend upon what is available, and when it is purchased, upon the comparative costs. The problem of a suitable supply of bedding at a reasonable cost is a serious one in regions such as the Eastern States where the growing of cereals is limited and as a result little home grown straw is available. Wheat straw ranks first as a bedding material. It is clean and has fair absorptive powers. Oat straw usually contains some dust but otherwise is of about the same value. Sometimes corn fodder is either shredded or run through a cutting machine and fed in the barn, the refuse making satisfactory bedding.

In localities where peat is common it is sometimes dug in the summer, allowed to dry in the field, and stored under cover when dry. It is found to make good bedding, having especially good absorptive powers. In the Eastern States shavings and sawdust are largely used. From a sanitary standpoint sawdust stands first as bedding material, followed by shavings. These materials are free from the large number of bacteria and molds which often accompany straw. However, bedding of this class does not add any fertility to the soil, as is the case when wheat or oat straw is used. Some objections have been raised to the use of sawdust and shavings as bedding material. Sawdust makes manure so light that loss of ammonia and sometimes loss from fire fanging occurs. Applied in large quantities to the soil it may be injurious from the effect of the acids set free, particularly tannic acid in the case of oak sawdust. The reasonable use of sawdust on most soils, however, is not injurious, and may even be beneficial.

APPENDIX A

TABLE 70. DIGESTIBLE NUTRIENTS IN FEEDS[1]

	Total Dry Matter	DIGESTIBLE NUTRIENTS			
		Crude Protein	Carbohydrates	Fat	Total
CONCENTRATES	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT
Corn, dent No. 2	85.2	7.1	64.6	4.4	81.7
Corn and cob meal	89.6	6.1	63.7	3.7	78.1
Hominy feed	89.9	70.0	61.2	7.3	84.6
Gluten meal	90.9	30.2	43.9	4.4	84.0
Gluten feed	91.3	21.6	51.9	3.2	80.7
Corn bran	90.0	5.8	56.9	4.6	73.1
Wheat	89.8	9.2	67.5	1.5	80.1
Wheat bran	89.9	12.5	41.6	3.0	60.9
Wheat middlings	89.5	13.4	46.2	4.3	69.3
Flour middlings	89.3	15.7	52.8	4.3	78.2
Red dog flour	88.9	14.8	56.5	3.5	79.2
Wheat screenings	89.8	9.6	47.3	3.6	65.0
Oats	90.8	9.7	52.1	3.8	70.4
Barley	90.7	9.0	66.8	1.6	79.4
Malt sprouts	92.4	20.3	47.4	1.3	70.6
Brewer's grains	92.5	21.5	30.5	6.1	65.7
Rye	90.6	9.9	68.4	1.2	81.0
Rice	90.4	4.7	64.6	1.7	73.1
Kaffir	88.2	9.0	65.8	2.3	80.0
Milo	89.3	8.7	66.2	2.2	79.9
Peas	90.8	19.0	55.8	0.6	76.2
Soybeans	90.1	33.2	24.7	16.1	94.1
Soybean meal	89.5	39.7	34.7	4.5	84.5
Peanut meal	93.4	40.3	22.5	9.2	83.5
Cottonseed meal	92.5	37.0	21.8	8.6	78.2
Cold pressed cottonseed cake	92.1	21.1	33.2	7.4	70.9
Flaxseed	90.8	20.6	17.0	29.0	102.8
Linseed meal O.P.	90.9	30.6	32.6	6.7	77.9
Linseed meal N.P.	90.4	31.7	37.9	2.8	75.9
Cocoanut meal	89.8	18.6	41.3	8.4	78.4

---

[1] Material in this table is taken by the express permission of F. B. Morrison from the tables in the eighteenth edition of "Feeds and Feeding."

TABLE 70, continued

	Total Dry Matter	Digestible Nutrients			
		Crude Protein	Carbohydrates	Fat	Total
	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT
MILK AND ITS PRODUCTS					
Whole milk	13.6	3.3	4.8	3.6	16.2
Skim milk	9.9	3.6	5.1	0.2	9.1
Butter milk	9.4	3.4	4.9	0.1	8.4
Whey	6.6	0.8	4.7	0.3	6.2
DRIED ROUGHAGE					
Alfalfa	91.4	10.6	39.0	0.9	51.6
Clover, red	87.1	7.6	39.3	1.8	50.9
Clover, alsike	87.7	7.9	36.9	1.1	47.3
Clover, sweet	91.4	10.9	38.2	0.7	50.7
Field peas	88.9	12.2	40.1	1.9	56.6
Cowpeas	90.3	13.1	33.7	1.0	49.0
Soybeans	91.4	11.7	39.2	1.2	53.6
Oat and pea	83.4	8.5	37.1	1.5	48.8
Timothy	88.4	3.0	42.8	1.2	48.5
Redtop	90.2	4.6	45.9	1.2	53.2
Prairie	93.5	4.0	41.4	1.1	47.9
Millet	85.7	5.0	46.0	1.8	55.0
Sudan Grass	88.7	3.7	45.7	0.9	51.4
Corn fodder	81.7	3.0	47.3	1.5	53.7
Kaffir fodder	91.0	4.1	45.0	1.7	52.9
Corn stover	81.0	2.1	42.4	0.7	46.1
Sorghum fodder	90.3	2.8	44.8	2.0	52.1
SUCCULENT ROUGHAGE—SILAGE					
Corn, mature	26.3	1.1	15.0	0.7	17.7
Corn, immature	21.0	1.0	11.4	0.4	12.3
Corn stover	20.6	0.6	10.7	0.4	12.2
Sorghum	22.8	0.6	11.6	0.5	13.3
Alfalfa	25.0	2.0	8.9	1.0	13.2
Clover	24.4	2.0	9.6	0.8	13.4
Soybeans	27.2	2.8	10.8	0.9	15.6
Sunflower	21.9	1.0	9.8	0.8	12.6

TABLE 70, continued

	Total Dry Matter	Digestible Nutrients			
		Crude Protein	Carbohydrates	Fat	Total
	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT
GREEN FORAGE					
Alfalfa	25.3	3.3	10.4	0.4	14.6
Clover, red	26.2	2.7	13.0	0.6	17.1
Clover, alsike	24.3	2.7	11.8	0.4	15.4
Clover, sweet	24.4	3.3	10.3	0.3	14.3
Peas, field	16.6	2.9	7.1	0.3	10.7
Cowpeas	16.3	2.3	8.0	0.3	11.0
Soybeans	23.6	3.2	10.2	0.5	14.5
Oats and peas	22.6	2.4	10.6	0.6	14.4
Corn fodder	21.9	1.0	12.8	0.4	14.7
Kaffir fodder	23.6	1.1	12.4	0.4	14.4
Oats	26.1	2.3	11.8	0.8	15.9
Rye	21.3	2.1	12.2	0.5	15.4
Millet	27.6	1.9	14.8	0.6	18.1
Sorghum	24.9	0.7	14.8	0.7	17.1
Blue grass	31.6	2.3	14.8	0.6	18.5
ROOTS					
Sugar beets	16.4	1.2	12.6	0.1	14.0
Mangels	9.4	0.8	6.4	0.1	7.4
Turnips	9.5	1.0	6.0	0.2	7.4
Rutabagas	10.9	1.0	7.7	0.3	9.4
Beet pulp, dry	91.8	4.6	65.2	0.8	71.6
Potatoes	21.2	1.1	15.8	0.1	17.1
Pumpkins	8.3	1.1	4.5	0.5	6.7

TABLE 71. MINERAL ELEMENTS OF COMMON FEEDS. PARTS PER 100[1]

Feed	Total Ash	Calcium	Phosphorus	Potassium	Sodium	Magnesium	Sulphur	Chlorine
Corn	1.21	.012	.260	.340	.026	.108	.147	.063
Gluten feed	3.18	.247	.542	.250	.424	.220	.585	.090
Kaffir corn	1.18	.012	.239	.254	.058	.125	.164	.104
Oats	3.38	.102	.395	.419	.168	.118	.195	.070
Wheat	1.64	.050	.373	.520	.031	.130	.084	.084
Wheat bran	6.06	.125	1.110	1.320	.201	.531	.267	.090
Wheat middlings	4.12	.096	.876	1.021	.165	.383	.234	.025
Cottonseed meal	6.98	.266	1.352	1.656	.259	.548	.490	.038
Linseed meal	5.80	.362	.705	1.098	.253	.488	.408	.085
Soybeans	5.06	.210	.592	1.913	.343	.223	.406	.024
Navy beans	3.78	.201	.367	1.186	.074	.176	.192	.040
Milk, skim	.69	.128	.094	.122	.047	.014	.034	.091
Bone flour		23.990	14.940	.065	.091	1.160		
Alfalfa hay	6.38	1.046	.221	.770	.453	.370	.276	.149
Clover hay	6.76	1.142	.169	1.701	.062	.270	.176	.239
Soybean hay	7.67	1.232	.212	1.586	.130	.619	.231	.075
Timothy hay	3.20	.177	.113	.564	.317	.102	.149	.183
Corn stover	6.52	.472	.095	1.718	.061	.086	.174	.287
Beet pulp, dry	2.91	.660	.062	.314	.167	.256	.125	.043
Potatoes	.67	.005	.047	.272	.031	.058	.025	.010

[1] From Bulletin 255, Ohio Experiment Station.

TABLE 72. NUMBER OF DAIRY CATTLE BY BREEDS AND STATES, 1920[1]

State	Total Dairy Cattle	Total Pure-bred Dairy Cattle	Per Cent of Pure-bred Dairy Bulls	Pure-bred Dairy Cattle by Breeds				
				Ayrshire	Guernsey	Holstein	Jersey	All Others
Alabama	721,574	6,108	9		46	1,142	4,608	312
Arizona	53,721	3,108	91	109	48	1,778	669	504
Arkansas	727,160	6,950	12		19	2,001	4,627	303
California	778,951	19,144	34	595	1,145	12,189	3,832	1,383
Colorado	322,193	6,448	26	114	241	4,057	1,605	431
Connecticut	162,739	10,284	46	1,250	1,566	4,859	2,257	352
Delaware	44,757	1,663	27		246	1,245	172	
Florida	120,631	2,930	15	46	68	337	2,380	99
Georgia	674,863	8,727	11	14	305	1,700	6,224	484
Idaho	202,391	4,138	34	46	197	2,049	1,579	267
Illinois	1,505,060	36,412	19	202	1,369	25,124	7,317	2,400
Indiana	946,401	21,115	21	509	1,215	8,477	9,921	993
Iowa	1,519,510	20,286	12	271	1,716	10,916	3,629	3,754
Kansas	929,753	17,058	19	694	477	10,408	4,784	695
Kentucky	659,794	8,829	16	20	40	2,046	6,421	302
Louisiana	316,532	3,415	14		94	1,009	2,201	111
Maine	267,273	15,683	56	1,134	1,836	7,206	4,999	508
Maryland	229,711	8,668	21	113	1,867	4,073	2,323	292
Massachusetts	206,010	18,807	57	1,880	3,348	10,006	2,904	669
Michigan	1,256,141	46,533	34	291	3,369	32,702	8,296	1,875
Minnesota	2,080,627	32,668	16	399	4,468	22,830	2,508	2,463
Mississippi	789,238	8,367	12		101	1,331	6,571	364
Missouri	1,066,750	19,037	17	110	760	5,569	10,708	1,890
Montana	211,098	3,451	25	13	176	2,453	560	249
Nebraska	689,708	7,873	9	74	348	5,368	1,275	808
Nevada	24,091	405	21	21	10	197	133	44
New Hampshire	145,376	10,750	54	1,214	1,151	6,695	1,348	342
New Jersey	172,693	11,538	29	265	1,747	7,810	1,368	348
New Mexico	62,794	1,327	32		42	438	507	340
New York	2,081,074	153,037	42	9,521	9,749	114,662	13,411	5,694
North Carolina	462,077	7,697	21	44	789	1,613	4,978	273
North Dakota	660,023	4,797	8	226	346	2,937	481	807
Ohio	1,349,373	70,882	32	1,021	4,960	38,327	23,842	2,732
Oklahoma	808,459	9,539	13		91	3,741	5,104	603
Oregon	280,411	12,852	48	323	697	3,624	7,771	437
Pennsylvania	1,315,803	75,189	28	3,097	9,618	48,652	11,036	2,786
Rhode Island	28,813	1,651	43	494	217	542	351	47
South Carolina	316,494	5,184	14		644	1,008	3,389	143
South Dakota	546,258	5,248	11	85	135	4,027	312	689
Tennessee	669,360	11,347	18		111	1,383	9,424	429
Texas	1,463,707	23,364	14	19	59	2,973	18,718	1,595
Utah	108,015	2,922	42		93	970	1,706	153
Vermont	421,280	28,549	52	3,808	2,193	13,413	8,446	689
Virginia	509,305	9,586	25	25	1,696	4,160	3,223	482
Washington	378,825	12,720	41	404	941	7,673	3,402	300
West Virginia	255,021	4,450	20	272	333	1,134	2,546	165
Wisconsin	2,763,483	114,917	43	1,712	18,727	80,845	7,791	5,842
Wyoming	58,192	1,071	29	21	31	747	167	105

[1] U. S. Census.

TABLE 73. GESTATION TABLE. THE AVERAGE PERIOD OF GESTATION WITH CATTLE IS 282 DAYS

DATE OF		DATE OF		DATE OF	
SERVICE	BIRTH	SERVICE	BIRTH	SERVICE	BIRTH
Jan. 1	Oct. 8	May 6	Feb. 11	Sept. 8	June 16
“ 6	“ 13	“ 11	“ 16	“ 13	“ 21
“ 11	“ 18	“ 16	“ 21	“ 18	“ 26
“ 16	“ 23	“ 21	“ 26	“ 23	July 1
“ 21	“ 28	“ 26	Mar. 3	“ 28	“ 6
“ 26	Nov. 2	“ 31	“ 8	Oct. 3	“ 11
“ 31	“ 7	June 5	“ 13	“ 8	“ 16
Feb. 5	“ 12	“ 10	“ 18	“ 13	“ 21
“ 10	“ 17	“ 15	“ 23	“ 18	“ 26
“ 15	“ 22	“ 20	“ 28	“ 23	“ 31
“ 20	“ 27	“ 25	April 2	“ 28	Aug. 5
“ 25	Dec. 2	“ 30	“ 7	Nov. 2	“ 10
Mar. 2	“ 7	July 5	“ 12	“ 7	“ 15
“ 7	“ 13	“ 10	“ 17	“ 12	“ 20
“ 12	“ 18	“ 15	“ 22	“ 17	“ 25
“ 17	“ 23	“ 20	“ 27	“ 22	“ 30
“ 22	“ 28	“ 25	May 2	“ 27	Sept. 4
“ 27	Jan. 2	“ 30	“ 7	Dec. 2	“ 9
April 1	“ 7	Aug. 4	“ 13	“ 7	“ 14
“ 6	“ 12	“ 9	“ 17	“ 12	“ 19
“ 11	“ 17	“ 14	“ 22	“ 17	“ 24
“ 16	“ 22	“ 19	“ 27	“ 22	“ 29
“ 21	“ 27	“ 24	June 1	“ 27	Oct. 4
“ 26	Feb. 1	“ 29	“ 6		
May 1	“ 6	Sept. 3	“ 11		

TABLE 74. ESTIMATED WEIGHT OF SETTLED SILAGE[1]

Depth of Silage, Feet	Estimated Weight of Silage to the Cubic Foot at This Depth	Average Weight of Silage to the Cubic Foot to This Depth	Diameter of Silo					
			10 ft.	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.
	LBS.	LBS.	TONS	TONS	TONS	TONS	TONS	TONS
1	32.0	32.0	1.2	1.8	2.4	3.2	4.0	5.0
2	32.7	32.4	2.5	3.6	4.9	6.5	8.2	10.1
3	33.4	32.7	3.8	5.5	7.5	9.8	12.4	15.4
4	34.1	33.1	5.1	7.4	10.1	13.3	16.8	20.7
5	34.8	33.4	6.5	9.4	12.8	16.7	21.2	26.2
6	35.4	33.7	7.9	11.4	15.5	20.3	25.6	31.7
7	36.0	34.1	9.3	13.5	18.3	23.9	30.3	37.4
8	36.6	34.4	10.8	15.5	21.1	27.6	34.9	43.2
9	37.4	34.7	12.2	17.6	24.0	31.3	39.6	49.0
10	38.0	35.0	13.7	19.7	26.9	35.1	44.4	54.9
11	38.4	35.3	15.2	21.9	29.8	39.0	49.3	60.9
12	38.8	35.6	16.7	24.1	32.8	42.9	54.2	67.0
13	39.2	35.9	18.3	26.3	35.9	46.9	59.2	73.2
14	39.6	36.2	19.9	28.6	39.0	50.9	64.3	79.5
15	40.0	36.4	21.4	30.8	42.0	54.8	69.3	85.7
16	40.2	36.7	23.0	33.2	45.2	59.0	74.5	92.1
17	40.4	36.9	24.6	35.4	48.3	63.0	79.6	98.4
18	40.6	37.1	26.2	37.7	51.4	67.1	84.8	104.8
19	40.8	37.3	27.8	40.0	54.5	71.2	90.0	111.2
20	41.0	37.5	29.4	42.4	57.7	75.3	95.2	117.7
21	41.2	37.6	31.0	44.6	60.7	79.3	100.2	123.9
22	41.4	37.8	32.6	47.0	64.0	83.5	105.6	130.5
23	41.6	38.0	34.3	49.4	67.2	87.8	110.5	137.2
24	41.8	38.1	35.9	51.7	70.4	91.9	116.1	143.5
25	42.0	38.3	37.6	54.1	73.7	96.2	121.6	150.3
26	42.2	38.4	39.2	56.4	76.8	100.3	126.8	156.7
27	42.4	38.6	40.9	58.9	80.2	104.7	132.3	163.6
28	42.6	38.7	42.5	61.2	83.4	108.9	137.6	170.1
29	42.8	38.9	44.3	63.7	86.8	113.3	143.2	177.1
30	43.0	39.0	45.9	66.0	90.0	117.5	148.5	183.6

[1] From Bulletin 164, Missouri Experiment Station.

When conditions of moisture and amount of grain are judged to be average, Table 74 is to be used as given. When conditions are extreme, the following modifications are suggested:

1. When the corn is put into the silo in a less mature condition than usual, for example, in the milk stage, or the beginning of the dough stage, add 10 to 15 per cent to the weights given in the table.
2. If the grain is unusually heavy in proportion to the stalk, add 5 to 10 per cent to the figures found in the table.
3. If the corn is considerably past the usual stage of maturity and clearly contains less water than usual, deduct 10 to 15 per cent.
4. If very little or no grain is present, deduct 10 per cent.

It is recommended that the same table be used for estimating the weight of sweet sorghum and Kafir silage.

APPENDIX B

SCORE CARD FOR AYRSHIRE BREED

Cow

Head, 10.	
Forehead—Broad and clearly defined	1
Horns—Wide set on and inclining upward	1
Face—Of medium length, slightly dished, clean cut, showing veins	2
Muzzle—Broad and strong without coarseness, nostrils large	1
Jaws—Wide at the base and strong	1
Eyes—Full and bright with placid expression	3
Ears—Of medium size and fine, carried alert	1
Neck, 3.	
Fine throughout, throat clean, neatly joined to head and shoulders, of good length, moderately thin, nearly free from loose skin, elegant in bearing	3
Fore Quarters, 10.	
Shoulders—Light, good distance through from point to point, but sharp at withers, smoothly blending into body	2
Chest—Low, deep, and full between and back of forelegs	6
Brisket—Light	1
Legs and Feet—Legs straight and short, well apart, shanks fine and smooth, joints firm; feet medium size, round, solid, and deep	1
Body, 13.	
Back—Strong and straight, chine lean, sharp, and open-jointed	4
Loin—Broad, strong, and level	2
Ribs—Long, broad, wide apart, and well sprung	3
Abdomen—Capacious, deep, firmly held up with strong muscular development	3
Flank—Thin and arching	1
Hind Quarters, 11.	
Rump—Wide, level, and long from hooks to pin bones, a reasonable pelvic arch allowed	3
Hooks—Wide apart and not projecting above back nor unduly overlaid with fat	2
Pin Bones—High and wide apart	1
Thighs—Thin, long, and wide apart	2
Tail—Long, fine, set on a level with the back	1
Legs and Feet—Legs strong, short, straight when viewed from behind and set well apart; shanks fine and smooth, joints firm; feet medium size, round, solid, and deep	2

Udder, 22.	
Long, wide, deep, but not pendulous, nor fleshy; firmly attached to the body, extending well up behind and far forward; quarters even; sole nearly level and not indented between teats, udder veins well developed and plainly visible	22
Teats, 8.	
Evenly placed, distance apart from side to side equal to half the breadth of udder, from back to front equal to one third the length; length 2½ to 3½ inches, thickness in keeping with length, hanging perpendicular and not tapering	8
Mammary Veins, 5.	
Large, long, tortuous, branching and entering large orifices	5
Escutcheon, 2.	
Distinctly defined, spreading over thighs and extending well upward	2
Color, 2.	
Red of any shade, brown, or these with white; mahogany and white, or white; each color distinctly defined. (Brindle markings allowed, but not desirable.)	2
Covering, 6.	
Skin—Of medium thickness, mellow and elastic	3
Hair—Soft and fine	2
Secretions—Oily, of rich brown or yellow color	1
Style, 4.	
Alert, vigorous, showing strong character; temperament inclined to nervousness, but still docile	4
Weight, 4.	
At maturity not less than 1,000 pounds	4
Total	100

BULL

Head, 16.	
Forehead—Broad and clearly defined	2
Horn—Strong at base, set wide apart, inclining upward	1
Face—Of medium length, clean cut, showing facial veins	2
Muzzle—Broad and strong without coarseness	1
Nostrils—Large and open	2
Jaws—Wide at the base and strong	1
Eyes—Moderately large, full, and bright	3
Ears—Of medium size and fine, carried alert	1
Expression—Full of vigor, resolution, and masculinity	3
Neck, 10.	
Of medium length, somewhat arched, large, and strong in the muscles on top, inclined to flatness on sides, enlarging symmetrically towards the shoulders, throat clean and free from loose skin	10

Fore Quarters, 15.	
Shoulders—Strong, smoothly blending into body with good distance through from point to point and fine on top	3
Chest—Low, deep, and full between back and forelegs	8
Brisket—Deep, not too prominent, and with very little dewlap	2
Legs and Feet—Legs well apart, straight, and short, shanks fine and smooth, joints firm, feet of medium size, round, solid, and deep	2
Body, 18.	
Back—Short and straight, chine strongly developed and open-jointed	5
Loin—Broad, strong, and level	4
Ribs—Long, broad, strong, well sprung, and wide apart	4
Abdomen—Large and deep, trimly held up with muscular development	4
Flank—Thin and arching	1
Hind Quarters, 16.	
Rump—Level, long from hooks to pin bones	5
Hooks—Medium distance apart, proportionately narrower than in female, not rising above the level of the back	2
Pin Bones—High, wide apart	2
Thighs—Thin, long, and wide apart	4
Tail—Fine, long, and set on a level with back	1
Legs and Feet—Legs straight, set well apart, shanks fine and smooth; feet medium size, round, solid, and deep, not to cross in walking	2
Scrotum, 7.	
Well developed and strongly carried	3
Rudimentaries, Veins, etc.—Teats of uniform size squarely placed, wide apart and free from scrotum; veins long, large, tortuous, with extensions entering large orifices; escutcheon pronounced and covering a large surface	4
Color, 3.	
Red of any shade, brown, or these with white, mahogany and white, or white; each color distinctly defined	3
Covering, 6.	
Skin—Medium thickness, mellow and elastic	3
Hair—Soft and fine	2
Secretions—Oily, of rich brown or yellow color	1
Style, 5.	
Active, vigorous, showing strong masculine character, temperament inclined to nervousness, but not irritable or vicious	5
Weight, 4.	
At maturity not less than 1,500 pounds	4
Total	100

SCORE CARD FOR BROWN SWISS BREED

Cow

Head, 12.	
Medium size and rather long	2
Horns—Short, regularly set with black tips	2
Face—Dished, narrow between horns and wide between eyes	2
Muzzle—Black, large and square with mouth surrounded by mealy colored band, tongue black	2
Eyes—Moderately large, full and bright	2
Ears—Large, fringed inside with light colored hair, skin inside of ear a deep orange color	2
Neck, 4.	
Straight, throat clean, neatly joined to head, shoulders of good length, moderately thin at the withers	4
Chest, 6.	
Low, deep and full between and back of forelegs	6
Body, 14.	
Back—Level to setting of tail and broad across the loin	6
Ribs—Long and broad, wide apart and well sprung from thin, arching flanks	3
Abdomen—Large and deep	5
Hind Quarters, 12.	
Hips—Wide apart, rump long and broad	4
Thighs—Wide, quarters not thin	4
Legs—Short and straight with good hoofs	2
Tail—Slender, well set on, with good switch	2
Udder, 24.	
Fore Udder—Wide, deep, well rounded but not pendulous, nor fleshy, extending far forward on the abdomen	12
Rear Udder—Wide, deep, but not pendulous, nor fleshy, extending well up behind	12
Teats, 8.	
Rather large, set well apart and hanging straight	8
Mammary Veins, 6.	
Large, long, tortuous, elastic and entering good wells	6
Color, 4.	
Shades from dark to light brown, at some seasons of the year grey, white splashes near udder not objectionable, light stripe along back. White splashes on body or sides objectionable. Hair between horns usually lighter shade than body	4
Hide, 3.	
Medium thickness, mellow and elastic	3
General characteristics, 7.	
Disposition—Quiet	2
Size, evidence of constitution, and stamina	5
Total	100

Bull

Head, 15.	
Same as cow	2
Horns—Same as cow	2
Face—Same as cow	2
Muzzle—Same as cow	2
Eyes—Same as cow	2
Ears—Same as cow	2
Expression—Full of vigor, resolution, and masculinity	3
Neck, 10.	
Of medium length, somewhat arched, large and strong in muscles on top, sloping symmetrically to shoulders. Shoulders large and strong, smoothly blending into body	10
Chest, 10.	
Same as cow	10
Body, 20.	
Back—Same as cow	10
Ribs and Abdomen—Same as cow	10
Hind Quarters, 16.	
Hips—Same as cow	6
Thighs—Same as cow	6
Legs—Same as cow	2
Tail—Same as cow	2
Scrotum, 15.	
Well developed and strongly carried	3
Rudimentary teats, squarely placed wide apart and free from the scrotum	6
Milk veins—Same as cow	6
Color, 4.	
Same as cow	4
Hide, 3.	
Same as cow	3
General characteristics, 7.	
Disposition—Quiet	3
Size, evidence of constitution, and stamina	4
Total	100

Dark, smoky skins very objectionable.

SCORE CARD FOR GUERNSEY BREED

Cow

Head—Clean cut, lean face, wide mouth and muzzle with open nostrils, full bright eye with gentle expression. Forehead long, broad between the eyes and dishing	6

Horns—Small at base, medium length, not too spreading	1
Neck—Long and thin: clean throat	2
Withers—Chine rising above shoulder blades that are moderately thick and not coarse	3
Back—Straight from withers to hips	8
Hips—Wide apart, not too prominent	2
Rump—Long, continuing with level of the back, also level between hip bones and pin bones	5
Thurls—Wide apart and high	2
Chest—Wide, and deep at heart, with least depression possible back of the shoulders	4
Body—Deep and long, with well-sprung ribs which are wide apart. Broad loin. Thin arching flank	10
Thighs—Thin, incurving seen from side, and wide apart from rear	2
Legs—Comparatively short, clean, wide apart and nearly straight when viewed from behind, squarely set under body	2
Hide—Loose and pliable, and not thick, with oily feeling	3
Tail—Neat and firm setting on, long, good switch	1
Udder—Veins prominent	2
Attachment to body long and wide	2
Extending well forward	5
Level and well up behind	4
Teats of good even size, well apart and squarely placed	5
Milk Veins—Long, crooked, branching and prominent, with large deep wells	4
Secretions Indicating Color of Product—Indicated by the depth of yellow, inclining toward orange of the pigment secretion in the skin, on the body generally, and especially discernible in the ear, at the end of bone of tail, around the eye, on the udder and teats and at the base of horns. Hoofs and horns amber colored	20
Color Markings—A shade of fawn with white markings	2
Size—Mature cows about 1,100 pounds in milking condition	5
Total	100

BULL

Head—Clean cut, lean face, wide mouth and muzzle, wide open nostrils, and full bright masculine eye. Broad between the eyes and dishing	8
Horns—Small at base, medium length, not too spreading	1
Neck—Long masculine neck with strong crest and clean throat	4
Withers—Chine rising above shoulder blades, that are moderately thick and not coarse	3
Back—Straight from withers to hips	8
Hips—Wide apart, not too prominent	2

Rump—Long, continuing with level of the back, also level between hip bones and pin bones	6
Thurls—Wide apart and high	2
Chest—Wide, and deep at heart, least depression possible back of shoulders	6
Body—Deep and long, with well-sprung ribs which are wide apart. Thin arching flank	10
Thighs—Thin, incurving seen from side, and wide apart from rear.	2
Legs—Comparatively short, clean, wide apart and nearly straight when viewed from behind, squarely set under body	2
Hide—Loose and pliable, and not thick, with oily feeling	5
Tail—Neat and firm setting on, long, good switch	1
Rudimentary Teats—Teats wide apart and squarely placed	3
Milk Veins—Long, crooked, branching and prominent, with large, deep wells	5
Secretions Indicating Color of Product—Indicated by the depth of yellow, inclining toward orange, of the pigment secretion of the skin on the body generally and especially discernible in the ear, at the end of bone of tail, around the eye, on the scrotum, and inside of thighs, and at base of horn. Hoofs and horns amber colored	20
Color Markings—A shade of fawn with white markings	5
Size—Mature bulls about 1,600 pounds	7
Total	100

SCORE CARD FOR HOLSTEIN BREED

Cow

Head—Decidedly feminine in appearance; fine in contour	2
Forehead—Broad between the eyes; dishing	2
Horns—Small; tapering finely towards the tips; set moderately narrow at base; oval; inclining forward; well bent inward; of fine texture; in appearance waxy	1
Face—Of medium length; clean and trim especially under the eyes, showing facial veins; the bridge of the nose straight	2
Muzzle—Broad with strong lips	1
Eyes—Large; full; mild; bright	2
Ears—Of medium size; of fine texture; the hair plentiful and soft; the secretion oily and abundant	1
Neck—Long; fine and clean at juncture with the head; free from dewlap; evenly and smoothly joined to shoulders	4
Shoulders—Slightly lower than hips; fine and even over tops; moderately broad and full at sides	3
Chest—Of moderate depth and lowness; smooth and moderately full in the brisket, full in the foreflanks (or through the heart)	6

Crops—Moderately full	2
Chine—Straight; strong; broadly developed, with open vertebræ	6
Barrel—Long; of wedge shape; well rounded; with a large abdomen, trimly held up (in judging the last item age must be considered)	7
Loin and Hips—Broad; level or nearly level between the hookbones; level and strong laterally; spreading from chine broadly and nearly level; hookbones fairly prominent	6
Rump—Long; high; broad with roomy pelvis; nearly level laterally; comparatively full above the thurl; carried out straight to dropping of tail	6
Thurl—High; broad	3
Quarters—Deep; straight behind; twist filled with development of udder; wide and moderately full at the sides	4
Flanks—Deep; comparatively full	2
Legs—Comparatively short; clean and nearly straight; wide apart; firmly and squarely set under the body; feet of medium size, round, solid and deep	4
Tail—Large at base, the setting well back; tapering finely to switch; the end of the bone reaching to hocks or below; the switch full	2
Hair and Handling—Hair healthful in appearance; fine, soft and furry; the skin of medium thickness and loose; mellow under the hand; the secretions oily, abundant, and of a rich brown or yellow color	8
Mammary Veins—Very large; very crooked (age must be taken into consideration in judging of size and crookedness); entering very large or numerous orifices; double extension; with special developments such as branches, connections, etc.	10
Udder and Teats—Very capacious; very flexible; quarters even; nearly filling the space in the rear below the twist, extending well forward in front; broad and well held up	12
Teats—Well formed; wide apart, plumb and of convenient size	2
Escutcheon—Largest; finest	2
Total	100

Bull

Head—Showing full vigor; elegant in contour	2
Forehead—Broad between the eyes; dishing	2
Face—Of medium length; clean and trim, especially under the eyes; the bridge of the nose straight	2
Muzzle—Broad with strong lips	1
Ears—Of medium size; of fine texture; the hair plentiful and soft; the secretions oily and abundant	1
Eyes—Large; full; mild; bright	2

Horns—Short; of medium size at base; gradually diminishing towards tips; oval; inclining forward; moderately curved inward; of fine texture; in appearance waxy	1
Neck—Long; finely crested (if the animal is mature); fine and clean at juncture with the head; nearly free from dewlap; strongly and smoothly joined to shoulders	5
Shoulders—Of medium height; of medium thickness, and smoothly rounded at tops; broad and full at sides; smooth over front	4
Chest—Deep and low; well filled and smooth in the brisket; broad between the forearms; full in the foreflanks (or through at the heart).	7
Crops—Comparatively full; nearly level with the shoulders	4
Chine—Strong; straight, broadly developed, with open vertebræ	6
Barrel—Long; well rounded; with large abdomen; strongly and trimly held up	7
Loin and Hips—Broad; level or nearly level between hook bones; level and strong laterally; spreading out from the chine broadly and nearly level; the hook bones fairly prominent	7
Rump—Long; broad, high; nearly level laterally; comparatively full above the thurl; carried out straight to dropping of tail	7
Thurl—High; broad	4
Quarters—Deep; broad; straight behind; wide and full at sides; open in the twist	5
Flanks—Deep; full	2
Legs—Comparatively short; clean and nearly straight; wide apart; firmly and squarely set under the body; arms wide, strong and tapering; feet of medium size, round, solid and deep	5
Tail—Large at base, the setting well back; tapering finely to switch; the end of bone reaching to hocks or below; the switch full	2
Hair and Handling—Hair healthful in appearance; fine, soft and furry; skin of medium thickness and loose; mellow under the hand; the secretions oily, abundant and of a rich brown or yellow color	10
Mammary Veins—Large; full; entering large orifices; double extension; with special development, such as forks, branches, connections, etc.	10
Rudimentary Teats—Large; well placed	2
Escutcheon—Largest; finest	2
Total	100

SCORE CARD FOR JERSEY BREED

Cow

Head, 7.

A. Medium size, lean; face dished; broad between eyes; horns medium size, incurving	3
B. Eyes full and placid; ears medium size, fine, carried alert; muzzle broad, with wide open nostrils and muscular lips; jaw strong	4

Neck, 4.	
Thin, rather long, with clean throat, neatly joined to head and shoulders	4
Body, 37.	
A. Shoulders light, good distance through from point to point, but thin at withers; chest deep and full between and just back of fore legs	5
B. Ribs amply sprung and wide apart, giving wedge shape, with deep, large abdomen, firmly held up, with strong muscular development	10
C. Back straight and strong, with prominent spinal processes; loins broad and strong	5
D. Rump long to tail-setting, and level from hip-bones to rump-bones	6
E. Hip-bones high and wide apart	3
F. Thighs flat and wide apart, giving ample room for udder	3
G. Legs proportionate to size and of fine quality, well apart, with good feet, and not to weave or cross in walking	2
H. Hide loose and mellow	2
I. Tail thin, long, with good switch, not coarse at setting-on	1
Udder, 26.	
A. Large size, flexible and not fleshy	6
B. Broad, level or spherical, not deeply cut between teats	4
C. Fore udder full and well rounded, running well forward of front teats	10
D. Rear udder well rounded, and well out and up behind	6
Teats, 8.	
Of good and uniform length and size, regularly and squarely placed.	8
Milk Veins, 4.	
Large, long, tortuous and elastic, entering large and numerous orifices	4
Size, 4.	
Mature cows, 800 to 1,000 pounds	4
General Appearance, 10.	
A symmetrical balancing of all the parts, and a proportion of parts to each other, depending on size of animal, with the general appearance of a high-class animal, with capacity for food and productiveness at pail	10
Total	100

BULL

Head, 10.	
A. Broad, medium length; face dished; narrow between horns: horns medium in size and incurving	5
B. Muzzle broad, nostrils open, eyes full and bold; entire expression one of vigor, resolution and masculinity	5

Neck, 7.	
Medium length, with full crest at maturity; clean at throat	7
Body, 57.	
A. Shoulders full and strong, good distance through from point to point, with well-defined withers; chest deep and full between and just back of fore legs	15
B. Barrel long, of good depth and breadth, with strong, rounded, well-sprung ribs	15
C. Back straight and strong	5
D. Rump of good length and proportion to size of body, and level from hip-bones to rump-bones	7
E. Loins broad and strong; hips rounded, and of medium width compared with female	7
F. Thighs rather flat, well cut up behind, high arched flank	3
G. Legs proportionate to size and of fine quality, well apart, with good feet, and not to weave or cross in walking	5
Rudimentary Teats, 2.	
Well placed	2
Hide, 2.	
Loose and mellow	2
Tail, 2.	
Thin, long, reaching the hock, with good switch, not coarse or high at setting-on	2
Size, 5.	
Mature bulls, 1,200 to 1,500 pounds	5
General Appearance, 15.	
Thoroughly masculine in character, with a harmonious blending of the parts to each other; thoroughly robust, and such an animal as in a herd of wild cattle would likely become master of the herd by the law of natural selection and survival of the fittest	15
Total	100

INDEX

Abortion, cause of, 435.
  guarding against in buying, 147.
  treatment for, 438.
Ayrshire, advanced register for, 94.
  characteristics of, 89.
  importations of, 88.
  origin of, 87.
  records of, 95.
  scale of points for, 576, 577.

Barns, 539–559.
  arrangement of cattle in, 549.
  basement type of, 540.
  covered yard system of, 543.
  floor construction, 545.
  gutters for, 552.
  lighting, 544.
  loft type of, 541.
  mangers for, 552.
  one-story shed, 542.
  round barn, 542.
  ties, 553.
  types of, 540.
Bedding, 566.
  amount required of, 567.
  material for, 568.
Beet pulp, composition of, 571.
  use as feed, 473, 493.
Bloat, 448.
Bos primigenius, 20, 21, 22.
Bos sondaicus, 20.
Bran, characteristics as a feed, 501.
  composition of, 569.
Breeding, cause of variation, 216.
  crossing, 229.
  early breeders, 211.
  Galton's law, 219.
  in-breeding, 223.
  line-breeding, 226.
  Mendel's law, 213.
  nicking, 228.
  out-crossing, 227.
  sex determination, 220.
Breeds, basis for selection of, 127.
  classification of, 25, 27.
  crossing of, 229.
  difference in use of roughage by, 135.
  origin of, 22.
  relative efficiency of, 130.
  type value of, 24.
Brewers' grains, 503.
  composition of, 569.
Brown Swiss cattle, 96.
  advanced registration, 101.
  characteristics of, 98, 101.
  conditions in native home, 96.
  importation of, 98.
  number in U. S., 98.
  origin of, 96.
  records of, 103.
Bull, age for service, 205, 206.
  age to select, 203, 204.
  associations, 232.
  cause of variation in prepotency of, 193, 194.
  dehorning of, 206.
  feed and management of, 207–210.
  feeding during growing period of, 204, 205.
  general importance of selecting, 183.
  influence of age of dam upon, 204.
  results of using pure-bred, 184–188.
  ringing of, 206.
  selection of, 194–203.
  stalls and shed for, 207, 208.
  variation in transmission of dairy qualities by, 189–193.

Calves, amount of milk to feed, 244.
  birth weights of, 237.
  calf raising, 235–281.
  diseases of, 275–281.
  feed required to raise, 241.
  feeding schedule for, 252.
  hay for, 247.
  lice on, 281.
  milk substitutes for, 254.
  minimum milk plan, 260.
  navel infection in, 280.
  pneumonia in, 279.
  powdered skim milk for, 265.
  prepared meals for, 256.
  ring worm, 280.
  scours in, 276.
  spring vs. fall, 251.
  supplements to skim milk, 245.
  ties for, 269.
  veal, feeding for, 270.
  whey as food for, 256.
Care and management, age profitable, 377.
  care after calving, 385.
  care at calving, 383.
  cause of decline in summer, 373.

  dehorning, 363.
  developing long milking period, 387.
  drying up, 379.
  fall vs. spring calving, 361.
  guarding against milk fever, 386.
  management of dry cow, 380.
  marking, 365.
  regularity in handling, 359.
  retention of afterbirth, 384.
  salt requirements, 391.
  sheltering, 368.
  the fly annoyance, 370.
  water for cows, 388.
  watering cows, 390.
Cattle (*See* cows, dairy).
  classification of, 25.
  marking, 365.
  origin of, 19.
Cement floors, 547.
Channel Island Breeds (*See* Jersey *and* Guernsey).
Community breeding, 137.
Corn, characteristics of, 500.
  composition of, 569.
  proper stage for silage, 528.
  stover, 496.
Cottonseed meal, characteristics as feed, 502.
  composition of, 569.
Cows, Dairy.
  a cheap producer of human food, 12.
  age and per cent fat, 425.
  age as influencing yield of milk, 181.
  care and management, 359–392 (*See* care and management).
  cause of individual variation in, 158.
  comparison with steer, 13.
  condition at freshening as affecting milk production, 300.
  factors influencing growth and development, 282–319 (*See* growth of cattle).
  fat content influenced by condition at calving, 417.
  judging by two-year-old record, 181.
  meat from, 15.
  number in U. S., 5, 573.
  relation of size to production, 312.
  selection by type, 28–46.
  selection of individuals, 149–182.
Cow Test Associations, 178.

Dairy farming (*See* dairy husbandry)
Dairy herd, keeping free from disease, 145.
  starting a, 142.
Dairy husbandry, a safe business, 16.
  and the labor problem, 16.
  history of, 1.
  land marks in development of, 3.
  place in permanent agriculture, 7.
  relation to soil fertility, 8.
Dairy type, 28.
  limitations of selecting by, 33.
Dehorning, 363.
  dehorning bulls, 206.
  use of caustic potash, 363.
Devons, 108.
Dexter cattle, 107.
Disease, prevention of, in starting a herd, 145.
Diseases of cattle, abortion, 435.
  bloat, 448.
  congestion or inflammation of the udder, 441.
  contagious abortion, 147, 436.
  cowpox, 449.
  drenching a cow, 429.
  foot rot, 447.
  garget, 440.
  impaction, 449.
  instruments and medicines needed for, 428.
  lumpy jaw, 449.
  milk fever, 443.
  pink eye, 447.
  tuberculosis, 429.
  udder troubles, 440.
Drying up a cow, 379.
Dual-purpose cattle, adaptations of, 111.
  definition of, 110.
Dutch Belted, characteristics of, 105.
  origin of, 104.

Feeding, 451–495.
  amount to feed, 460, 465, 483.
  feeding after freshening, 482.
  feeding as individuals, 464.
  feeding on pasture, 453.
  keeping summer conditions in winter, 459.
  lightness of ration, 472.
  limits of grain feeding, 485.
  mineral matter, 475.
  on official test, 490–495.
  order of feeding, 484.
  proportion of nutrients from roughage, 465.
  relation to live weight, 463.
  soiling vs. silage, 455–460.
  succulent feeds, 466.
  the protein supply, 467.
  turning on pasture, 452.

Feeding Standards, 509–520.
  deficiencies of, 154.
  how derived, 510–513.
  maintenance, 513.
  use of, 513–515.
  value of, 516.
Feeds, alfalfa-molasses, 507.
  characteristics of various feedstuffs, 496–508.
  composition of, 509.
  concentrates, 500–505.
  cooking, 480.
  determining cost of nutrients in, 578
  fertilizing value of, 10.
  fodders, 496.
  grinding, 478.
  hays, 497.
  mixed feeds, 505.
  molasses feeds, 505, 507.
  palatability of, 469.
  roots, 499.
  silage, 498.
  soaking, 481.
  steaming, 480.
  stock foods, 508.
  straws, 497.
  table of composition of, 569.
Flies, protection from, 372.
  species of, on cattle, 371.
Floor, material for barn, 545.
Foot Rot, 447.
Free-martin, 222.
French-Canadian cattle, 106.

Growth of cattle, breed as a factor, 281
  cause of, 287.
  factors influencing, 282.
  gestation and growth, 290.
  lactation and, 292.
  measuring, 283.
  nature of, 282.
  normal, 284, 320.
  nutrition and growth, 296.
  recovery from retarded, 306.
  size of calf and, 288.
Guernsey cattle, advanced register for, 84.
  conditions in native home of, 78.
  families, 84.
  form and characteristics of, 81, 83.
  importations of, 81.
  numbers in U. S., 81.
  origin of, 78.
  records of, 84.
  scale of points for, 580.

Hay, composition of various kinds, 579.
  various kinds, 497.
Heifers, age to breed, 334.
  care before calving, 334.
  factors influencing the size of, 288–310.
  feed after weaning, 321.
  influence of feeding when young, 313.
  milking the, 393.
  normal growth of, 320.
  winter rations for, 327.
Holsteins, advanced register for, 59.
  characteristics of breed, 53.
  characteristics of Holstein milk, 57.
  families of, 59.
  importations of, 49.
  milk and records, 56, 61, 62.
  number in U. S., 49.
  origin of, 47.
  records of, 62.
  scale of points for, 582.

Jersey cattle, characteristics of, 69, 70.
  conditions in native home of, 64.
  families of, 76.
  importations of, 60.
  influence of English breeders, 68.
  origin of, 64.
  records, 76.
  Register of Merit for, 74.
  registration on Jersey Island, 65.
  scale of points for, 584.
  types of, 67.

Kerry cattle, 107.

Lice on cattle, 446.
Linseed oil meal, characteristics as feed, 503.
  composition of, 569.

Maintenance ration, 513.
Manure, amount voided, 560.
  composition of, 560.
  distribution of fertilizing constituents in, 560.
  handling of, 564.
  losses, 561.
  preservation of, 563.
  value of, 561.
Marking systems for cattle, 365.
Mendel's law, 213.
Milk, advanced registry compared to ordinary, 421.
  as food, 6.
  bitter or stale, 405.
  bloody, 398.
  cause of secretion, 310, 482.
  condition of flesh at calving, 417.

  constituents produced by cow in a year, 14.
  daily variations, 404.
  drugs, 419.
  factors influencing quantity and quality, 402–426.
  first and last drawn, 416.
  gestation, 413, age, 425.
  interval between milking, 403.
  œstrum, 418.
  records, method of keeping, 170.
  relation between daily and yearly production, 419.
  richness as influenced by age of cow, 425.
  season, 406.
  skim milk, composition of, 239.
  stage of lactation, 408.
Milk fever, 443.
  air treatment for, 445.
Milking, before calving, 382.
  hard-milking cows, treatment for, 397.
  methods of, 393.
  more than twice daily, 395.
  the heifer, 393.
  tubes, 397.
Milking machines, 399.
Milk sheets, 175.
Milk tubes, 397.
Milk veins, 37.
Milk wells, 37.
Molasses feeds, use of, 505, 507.
Morrison Feeding Standard, 513.

Oat and oat products, characteristics as a feed, 501.
  composition of, 569.

Pasture, feeding grain on, 453.
  provisions for periods of short, 455.
  turning on, in spring, 452.
Pink eye, 447.
Pure-bred cattle, breeders' code, 349.
  definition, 338.
  naming of, 352.
  number of, in U. S., 345.
  official testing, 339.
  pure-bred vs. grades, 346.
  registration, 338.
  selling of, 355.
  the breeder of, 348, 353.

Rations, calculation of, 513.
  for high-producing cows, 490.
  order of feeding, 484.
  palatability of, 469.
Records, methods of keeping, 170–178.
Red Polled cattle, advanced registry for, 126.
  characteristics of, 123.
  origin of, 121.
Roots for feeding, 499–500.

Salt, amount needed, 392.
  necessity for, 391.
Sampling milk for testing, 173.
Score Card, Ayrshire, 576.
  Brown Swiss, 579.
  for general use, 45.
  Guernsey, 580.
  Holstein, 582.
  Jersey, 584.
  origin of, 42.
  use of the, 42.
Selection of cows, by records, 165–182.
  by type, 28–46.
Self-sucking cows, 399.
Shorthorns, advanced registration, 120.
  breed organizations, 119.
  characteristics of, 116.
  dairy records of, 120.
  in England, 119.
  origin of, 114.
Silage, characteristics as a feed, 498.
  composition of, 569.
  crops for, 526–529.
  fermentations in, 523.
  for summer feeding, 456.
  legume, 499, 528.
  pea and oats, 498.
  proper stage of maturity in corn, 528.
  sorghum, 498, 527.
  spoiling of, 530.
  sunflower, 499.
Silos, advantage of, 521.
  capacity of, 531.
  concrete, 525.
  filling, 529
  history of, 521.
  pit, 526.
  size to build, 524.
  the summer silo, 458.
  the wooden, 525.
  tile, 526.
Soiling system, 532–538.
  advantages of, 532.
  crops for soiling, 536.
  objections to, 535.

Teats, chapped, 398.
  leaking, 398.
  warts on, 399.
Test Associations, 178.

Timothy hay, characteristics as a feed, 497.
  composition of, 569.
Tuberculin test, 432.
Tuberculosis, 429.
Type, the dairy, 28.

Udder, defective udders, 40.
  good types of, 39.
  importance of, 38.
Udder troubles, chapped teats, 398.
  garget or inflammation, 440.
  instruments for treating, 428.
  leaking teats, 398.
  warts on teats, 399.

Veal, 270–275.
  classification of, 273.
  feeding for, 272, 274.
Ventilation, 556.
  forced ventilation, 558.
  forces causing ventilation, 557.
  King system, 557.
  window, 558.

Water, amount required for cows, 388.
  warming water for cows, 390.